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The AUTOMOBILE

VOL. XXXVI NEW YORK—THURSDAY, MAY 24, 1917—CHICAGO No. 21

Must Continue Battle Against Unjust 5% Tax

House Amendment Makes Tax Apply Only to Companies Earning 8% Plus $5,000 on Capital

This Amendment Is Unsatisfactory Because It Heightens Discriminatory Nature of Tax

WASHINGTON, May 22 — The House of Representatives today voted as a committee of the whole to modify the 5 per cent tax on sales of cars, trucks and tires at the factory embodied in the war revenue bill tax by making it applicable only to the products of companies earning more than 8 per cent on the capital invested plus $5,000. This amendment, proposed by Representative Doremus of Michigan, was adopted by a vote of ninety-six to ninety-two after the members had failed to agree to strike out the entire paragraph of the bill relating to the 5 per cent tax on factory sales of automobiles, etc.

The bill was also amended to provide that there shall be deducted from the tax on cars and trucks 5 per cent of the amount paid for the tires.

Dealers Must Pay

A committee amendment was also adopted which provides that the 5 per cent tax shall apply also to automobiles, trucks and tires in the hands of distributors and dealers on the day the revenue bill becomes law. When these have been bought by dealers and distributors since April 6, 1917, the tax is also to apply.

How greatly dealers will be affected by this provision is evident from the fact that since April 6 Detroit factories alone have shipped 214,500 cars to dealers. This represents millions of dollars investment and *each dealer would have to pay* $20 *to* $100 *apiece tax on these cars without counting what he would have to pay in taxes on trucks and tires bought since April* 6. With sales falling off this would mean unprecedented hard times for dealers all over the country and many would be forced to the wall.

Alfred Reeves, general manager of the National Automobile Chamber of Commerce, asserts that the automobile industry will continue to fight the tax; that the amendment adopted by the House in committee of the whole would not be acceptable to the industry, and that it would wage the fight to the end. Mr. Reeves said:

Industry Continues Fight

"The automobile industry protests against a tax on gross business as being discriminating and unscientific. It will continue its efforts to prove the truth of that statement to the lawmakers. It is ready to give up any part of its profits, but is against any plan that will have a tendency to make profits impossible.

"The amendment adopted in committee of the whole still retains the 5 per cent tax, but proposes to exempt concerns that make less than 8 per cent on their invested capital exclusive of good will.

"The industry is against it because it still discriminates against the automobile manufacturer and further discriminates among the automobile manufacturers themselves. The National Automobile Chamber of Commerce is making this fight with a view to having the automobile industry taken out of the class of face powder, perfumery, etc., and treated just the same as the

Keep On Fighting!

The House has recognized the injustice and discrimination of the proposed tax of 5 per cent on car, truck and tire sales and has tried to modify it. This is an added argument for completely eliminating such a tax from the war revenue bill when it comes before the Senate.

In the meantime, keep on fighting! The dealers are threatened by large losses and perhaps failure if this tax goes through. Manufacturers in all fields connected with the automobile industry will suffer.

Wire your protest to the Senate Finance Committee.

Government treats the Standard Oil, the steel corporations, and the meat industry.

"It asks no more than the same treatment accorded other legitimate industries, and it declines to accept any less. While it is expected that the amendment will be defeated in the final roll-call before the House, and the original form of tax come up for consideration again, it is believed that the Senate in rewriting the revenue bill will put the billion-dollar industry of motor car making and selling on a par with other industries of the country."

It is probable that the Senate finance committee will practically rewrite the bill as passed by the House and the entire elimination of the paragraph relating to the 5 per cent tax on the automobile industry is confidently expected, as the senators have a much more thorough knowledge of the great problems now confronting the industry than the members of the House.

It has developed that a proposition which was seriously discussed by the ways and means committee of the House, but discarded on the advice of the attorney general that it would not be constitutional to tax automobiles in the hands of individual owners in proportion to horsepower may be advanced in the Senate in lieu of the 5 per cent tax in the House bill.

Senator Boies Penrose of Pennsylvania, while not discussing in detail changes which he will recommend and fight for in the revenue bill, stated emphatically that this bill would be revised and practically rewritten in the Senate. Mr. Penrose is ranking Republican member of the Senate finance committee.

Makers' Arguments Effective

The arguments presented by representatives of the National Automobile Chamber of Commerce by fifty or more individual automobile manufacturers and by others interested in the industry to the Senate finance committee are said to have made a distinct impression. The feeling among members of this committee is said to be that automobile and accessory manufacturers will be bearing all of their fair share of the war burdens when they satisfy the income tax requirements, the excess profits tax, and place their entire resources at the disposal of the government in the making of cars, trucks, motors, or munitions of war generally.

Senators New and Watson of Indiana; Smith and Townsend of Michigan, possibly Harding of Ohio, and others, are ready to make a fight on the floor if necessary to see that the autmobile industry is given fair treatment at the hands of Congress, should such a step be necessary. It is believed, however, that the finance committee will take into consideration the position of the automobile and accessory manufacturers, and see that they are given the right treatment in reporting the bill.

There Is Still Time

Despite the fact that the 5 per cent tax has passed the House, there is still time to oppose it in the Senate. This tax will hurt the business of every manufacturer, dealer and garageman.

There is still time to defeat the bill. Wire your vigorous protest at once to the following committee at Washington:

Senate Finance Committee

F. McL. Simmons	North Carolina
W. J. Stone	Missouri
J. S. Williams	Mississippi
Hoke Smith	Georgia
Charles S. Thomas	Colorado
William Hughes	New Jersey
Ollie M. James	Kentucky
Thomas P. Gore	Oklahoma
A. A. Jones	New Mexico
Peter G. Gerry	Rhode Island
Boies Penrose	Pennsylvania
H. C. Lodge	Massachusetts
P. J. McCumber	North Dakota
Reed Smoot	Utah
J. H. Gallinger	New Hampshire
Robert M. LaFollette	Wisconsin
C. E. Townsend	Michigan

A Strong Case

The brief filed with the committee by Alfred Reeves, general manager of the National Automobile Chamber of Commerce, on behalf of the automobile industry, is said by members of the committee to be one of the strongest arguments yet presented in behalf of equitable and non-discriminatory treatment for a certain industry.

Senator James E. Watson of Indiana, one of the most capable and effective orators of the Senate, is expected to take the floor if necessary in behalf of fair treatment for the makers of automobiles. He will be followed by others of the Senate, all well prepared to discuss the subject.

Among a number of excellent speeches clearly bringing out the unjust and discriminatory nature of the proposed 5 per cent tax three merit special mention. These were made by Representative Doremus of Detroit, who led the fight in the House against the measure, Representative Kelly, Lansing, Mich., and Representative Focht of Pennsylvania.

Amendment Beaten on Final Vote

WASHINGTON, May 23.—In the final roll call on the war revenue bill to-day the House defeated the amendment making the 5 per cent tax on automobile, truck and tire sales at the factory apply only to companies earning 8 per cent plus $5,000. This is the amendment proposed by Representative Doremus of Michigan, and which was adopted by the House yesterday, voting as a committee of the whole.

The defeat of this amendment in the final roll call was expected by the automobile manufacturers, who looked upon the amendment as in no way tending to modify the discriminatory and unscientific nature of the proposed tax. It is believed that the Senate will practically rewrite the entire revenue bill, and will then place the automobile industry in its proper class with other great businesses of the country, instead of classing it with cosmetics and amusement manufactures.

Three Excellent Speeches

Mr. Doremus emphasized the national character of the industry, its magnitude and the small margin of profit upon which most of the manufacturers operate. He cited the statistics of the industry compiled by the N. A. C. C., which appeared in THE AUTOMOBILE last week, and drew attention to the discriminatory feature of the proposed 5 per cent tax by contrasting it with the taxes laid on the steel, copper, woolen and other great industries.

The great success of the Ford Motor Co., Mr. Doremus pointed out, has created an erroneous impression in the minds of many people as to the profits of the automobile manufacturers. In this connection he said in part:

"To illustrate the point by a few concrete examples. I submit to you, gentlemen, that there has been a great deal of misrepresentation — unintentional, no doubt—in considering this question. A great deal has been said not only to becloud the issue but to cast a prejudice upon the entire automobile industry.

"Take the Studebaker corporation. You have all heard of that. Upon a business of $23,600,000 with its principal model last year it earned 7½ per cent. You propose by this bill to take 5 per cent of their gross sales.

"The Chalmers, another car of which you have heard, upon a gross business of $18,000,000, paid 2.1 per cent. By this bill you propose to snag 5 per cent of the gross sales of that business.

"I am giving you, members of the committee, the facts in regard to this industry. The Overland, with the second largest production in America, ranking next to the Ford, on sales of $80,000,000 made a profit of 10 per cent.

"The Hupmobile, the president of which was a former Member of this House—my predecessor here—upon car sales of $10,000,000 made 1.1 per cent.

"You propose by this bill to step in and take 5 per cent of those gross sales. And yet men upon the floor of this House attempt to defend this wrong upon the ground that 'we need the money.'

"Now, a few more. The Chandler company, upon a business of $12,860,000, made 11 2/5 per cent. The Winton company, upon sales of $9,150,000, made 4 2/5 per cent. You propose by this bill to take 5 per cent of their sales. The Saxon company, upon sales of $15,000,000, made 8 per cent.

"Now, my friends, this list could be multiplied, but I have not the time to do it. The Hudson company, for instance, made 8 per cent on its gross sales of

$28,000,000. The manufacture of automobiles is a hazardous business. The path of this industry is strewn with the wrecks of ruined fortunes, dismantled factories, and disappointed ambitions. Within 5 years 718 concerns have failed or gone out of business, and to-day places are advertised where parts can be obtained for 217 'orphan' cars—cars once manufactured but no longer on the market.

"The other day you and I voted to authorize the purchase of 4000 or 5000 automobiles for this war. Yet, my friends, this instrumentality of commerce, so vital to our industrial welfare, so essential to the Nation's business, and so indispensable to the successful prosecution of this great war, is classed by the Ways and Means Committee as a luxury."

Revenue Estimate Incorrect

Pointing out that estimate of the revenue to be derived from a 5 per cent tax is incorrect because based upon last year's production, Mr. Doremus cited comparative statistics on the production of several representative companies for last year and this year. These showed a considerable reduction in volume for this year due to the increased cost of materials and smaller market caused by war conditions.

In reference to the greatly increased price of materials, Mr. Doremus stated:

"Frame steel (chassis, 120 lb. to make a frame): Eighteen months ago cost $1.35 per 100 lb.; present price, $5.25 per 100 lb. Increase, 270 per cent.

"Body and fender steel (250 lb. per car): Eighteen months ago cost $2.75 per 100 lb.; present price, $8.15 per 100 lb. Increase, 196 per cent.

"Stove-pipe iron (used for making mud-pans, mufflers, etc.): Eighteen months ago cost $1.85 per 100 lb.; present price, $5.75 per 100 lb. Increase, 200 per cent.

"Cast iron (standard northern pig iron, 370 lb. per car): Eighteen months ago cost $13.35 per ton; present price, $43 per ton. Increase, 222 per cent.

"Malleable iron (used for transmission cases, motors, and rear axle parts, 130 lb. per car): Eighteen months ago cost $3.90 per 100 lb.; price Jan. 1, 1917, $6.75 per 100 lb. Increase, 70 per cent.

"Forging billets (used in front axle forging and other plain forging, 135 lb. per car): Eighteen months ago cost $40 per ton; present price, $105 per ton. Increase, 162½ per cent.

"Brass and copper (radiator and carbureter and electric equipment): Eighteen months ago cost 16½ cents per pound; present price, 38 cents per pound. Increase, 130 per cent.

"Rubber tires: Increase, 50 per cent.

"And so I might go on and take up every part of this car and show that the increases run all the way from 50 per cent to over 300 per cent.

"The percentage of sales in the automobile industry that goes into advertising does not exceed 2 per cent," said Mr. Doremus, who then quoted the following statement from Martin's Merchandising Reporting Service of May 15, showing the percentage of sales spent by prominent advertisers for this purpose:

	Per Cent
Arrow collars	3½
Cloth-craft clothes	1½
Colgate's preparations	2
Fatima cigarettes	5
Ivory soap	3
Kodaks	3
Old Dutch cleanser	10
Phonographs	5
Sears-Roebuck & Co.	10
Sherwin-Williams paint	3½
Universal Portland cement	2
Velvet tobacco	6
Wooltex clothes	2

In closing Mr. Doremus said:

"The gentleman from Michigan (Mr. Fordney) admitted that the automobile paragraph of this bill is wrong, and could only be defended upon the ground that we need the money. Yet, in an elaborate presentation of figures he demonstrated that this bill will yield $200,000,000 more than the administration asks us to raise. The plea that we need the money will not suffice for an abuse of the taxing power. No exigency, however great, would justify the Congress in the commission of an acknowledged wrong against any portion of our people."

Industry of National Importance

Mr. Kelly showed how under the revenue bill an automobile or truck company must pay a gross sales tax of 5 per cent on its output in addition to the corporation tax of 4 per cent and the excess profit tax of 16 per cent, whereas other industries must pay only the latter two. This would work out that an automobile concern would pay a tax of $105,760 on gross sales of $2,000,000 as compared with only $35,120 paid by a company in another line of business on the same amount of sales.

The mistake of classifying the automobile industry with amusement manufactures was strongly brought out by Mr. Kelly as follows:

"The fact is that the Committee on Ways and Means has done itself a great injustice in taking the automobile industry out of the list of great industries where it of right belongs and putting it in a group of manufactures of the holiday amusement variety. The automobile is not a plaything like a phonograph or a fishing rod or a tennis racquet. It is a great independent, individual instrumentality of transportation and trade.

"There are in existence in this country more than 3,500,000 automobiles and trucks carrying state licenses, or on the average one car for every twenty-nine persons, men, women and children. In the great agricultural states of Iowa and Nebraska there is one automobile for every thirteen persons. The farmers of the great Middle West apparently do not consider the automobile in the same class with golf balls, tennis racquets and chewing gum. They consider it a great economic agency of transportation of themselves, their families and their products. Nobody knows the value of an automobile better than the men who live in the country. It is actually transforming country life by destroying the isolation of it."

Refuting the contention that the automobile industry is local, Mr. Kelly told of the widespread connections of the industry, which draws its supplies from every part of the world as well as practically every state in the Union. In this connection he said:

Quantity of Material Used

"The quantity of material used annually in the automobile business is a matter of constant amazement to those who have examined the figures. In 1916 the automobile industry used $20,000,000, of brass, purchased mainly in Kentucky, New England, New York, Pennsylvania and Wisconsin. More than $32,000,000 of copper was purchased in New England, Michigan, Wisconsin, Montana and other Western States; $25,000,000 of cotton fabric from the cotton mills of New England and the South; $22,000,000 of coal and coke from Pennsylvania and West Virginia; $5,000,000 of glass from Pennsylvania, Ohio and West Virginia; $26,000,000 of tin from Pennsylvania, Ohio and West Virginia; $7,500,000 of zinc from Missouri, Colorado and Nevada; $16,500,000 of lead from Colorado and Missouri; $10,000,000 of hardware from New York, Illinois, Pennsylvania and New England; $16,800,000 of oil from Oklahoma, Texas and Ohio; $9,000,000 of mohair from Texas and Oregon; $24,000,000 of hides and hair from Illinois, Nebraska and Missouri; $150,000,000 of lumber from Tennessee, Arkansas, Mississippi, Georgia and other Southern and Western States; and $250,000,000 of iron and steel from Alabama, Minnesota, Illinois, Ohio, Pennsylvania, West Virginia and Maryland. It is believed by many that not less than 2,000,000 men are employed in factory, mill and mine directly and indirectly as a result of the development of the automobile industry. In view of the magnitude of the figures just given Congress should give most careful consideration to any proposal affecting this great industry adversely."

The great problems confronting the industry affect not only the manufacturers of cars and trucks, but also those making parts and accessories as well as the dealers and garagemen throughout the country. Mr. Kelly told how sales have fallen off since war was declared, how the price of materials, cost of transportation and wage increases have increased the cost of manufacture.

Ford's Contribution

Mr. Focht's address was a close analytical study of the business and manufacturing methods of the Ford Motor Co., Detroit, bringing out several conclusive arguments against the injustice and impracticality of the proposed 5 per cent tax. Mr. Focht showed the benefits of the great educational work conducted by the company and touched on the success attending the development of its industrial relation plan, whereby, during the past year, 74 per cent of the 49,870 employees of the company shared in its profits.

U. S. Asks Bids from Makers

$118,000,000 Worth of Cars and Trucks Wanted in Lots of One to 1000

WASHINGTON, May 22—The War Department, through the Quartermaster's Corps, has asked all manufacturers of automobiles and motor trucks in the country to submit bids for furnishing motor vehicles in quantities of from 1 to 1000. This is being done in anticipation of the final approval of the special army appropriation bill by Congress.

The War Department has appropriated $118,000,000 for the purchase of motor vehicles for army work.

Representatives of the Quartermaster's Corps are now visiting the various factories to ascertain what each can do under present conditions if called upon in an emergency. Inquiries now being made are on the basis of 10,000 vehicles to be ordered promptly.

Bids are to be opened at 2 p. m., June 8, according to the requests which are being sent out from the headquarters of the central departments in Chicago. They will then be forwarded to the War Department here.

Passenger car makers have been asked for bids as follows, all in quantities of 1 to 1000:

Type	Price
Five-passenger	$1,000 or under
Two-passenger	1,000 or under
Touring cars	1,500 or under
Touring cars	2,000 or under

On June 10 bids will be opened for 1 to 35,000 1½-ton trucks and for 1 to 35,000 3-ton trucks.

On June 11 bids will be opened for 1 to 200 ½-ton trucks; 1 to 200 ¾-ton trucks; and 1 to 200 1-ton trucks.

On June 13, 1 to 5000 motorcycles complete and 1 to 5000 motorcycles with side cars.

No awards will be made under this opening of bids but offer and prices remain open during the fiscal year beginning July 1, purchases being made by the army as required. Prices to be quoted are f. o. b. factory. Time required to ship after receipt of order is one of the points on which information is requested. All vehicles bought are to be inspected by the government on delivery.

The opening of these bids in Chicago will mark the new policy of the Quartermaster's Corps, which is to buy motor cars in the future through the Chicago instead of the New York offices.

—

Cleveland S. A. E. Studies Steel Carbonization

CLEVELAND, May 21—The May meeting of the Cleveland Section of the Society of Automotive Engineers was held Friday evening, May 18, in the rooms of the City Club in the Hollenden Hotel. The speaker of the evening was J. H. Herron, consulting metallurgical engineer. His subject was "Some New Phases of Carbonization of Steel."

Mr. Herron has been conducting many investigations along these lines, but his work has not yet been completed so he could report definitely upon the outcome of his experiments. He presented some curves which show variation of physical property with drawing temperatures, etc. He also gave a table for which Dr. Mathews is responsible, showing the per cent of softening for different drawing temperatures. According to the table, the maximum softening was reached when drawing back to a temperature of 1300 deg. Fahr.

—

Spark Plugs Indiana S. A. E. Subject

INDIANAPOLIS, May 19—The manufacture of spark plugs will be the subject at the next meeting of the Indiana Section of the Society of Automotive Engineers on May 25. Albert Champion, general manager and vice-president of the Champion Ignition Co., Flint, Mich., will be the speaker. New officers will be appointed.

—

Season's Final Meeting at Detroit

DETROIT, May 21—The final meeting of the season of the Detroit section of the Society of Automotive Engineers will be held next Thursday night. K. W. Zimmerschied, chief metallurgist of the General Motors Co., will read a paper detailing the governmental plans for the war that interest the members of the S. A. E.

—

Pennsylvania S. A. E. Outing May 26

PHILADELPHIA, May 22—The Pennsylvania section of the Society of Automotive Engineers will hold an outing to Grenloch Park, N. J., about 8 miles from Camden, May 26. The cars will start at 1.30 p. m. from the Bellevue Stratford Hotel.

—

Government Picks Joy Field

DETROIT, May 21—The United States Government war department has formally taken over by lease the Henry B. Joy aviation field near this city. Work of erecting new buildings for the aviation corps will begin this week.

—

Aviation Training Near Dayton

DAYTON, OHIO, May 21—The United States Government has leased 2500 acres of farm land north of this city for an aviation training school. It will be a four-squadron school, the largest in the world. The Wright airplane school, organization of which was recently announced in THE AUTOMOBILE, will assist in giving flying lessons.

—

Liberty Bonds Buy Cole Cars

NEW YORK, May 23—The Cole Motor Car Co., Indianapolis, has taken the initiative in regard to selling its cars for Liberty Bonds. The company will accept Liberty $100 bonds on the basis of $102 for the entire or partial payment on its cars.

Plan 3500 Airplanes for 1917

Coffin Heads Aircraft Production Board—To Stimulate Manufacture

WASHINGTON, May 20—The Council of National Defense to-day announced the creation of an Aircraft Production Board, to be headed by Howard E. Coffin. This step, according to Mr. Coffin, marks the completion of plans to turn out in American factories about 3500 airplanes this year and double the output next year. They will include both training and battle types.

Among the members of the rest of the aircraft board is Sidney D. Walden, former Packard vice-president and later a member of the Cadillac company.

The Aircraft Production Board will act in the closest co-operation with the War and Navy departments, especially with the recently created joint army and navy board on design and specifications. Manufacturers will be brought together to help make their resources available to the Government and assist in stimulating the production of better types and greater quantities of airplanes.

Arrangements have been made, according to Mr. Coffin, with the British and Canadian officers to standardize the training machine in use in Great Britain, Canada and the United States, so that machines can be distributed impartially and without difficulty among the three nations.

The first three aviation camps to be established will be at Dayton, Ohio; Detroit, Mich., and Champaign, Ill. There will be in all nine such camps, each covering an area of 1 mile square, at which 3000 men will be trained for an aviation expedition to France.

Two squadrons of 150 students each, with the necessary officer instructors and enlisted men, will be accommodated at each camp. Hangars will take care of seventy-two airplanes. Each field will cost $1,000,000 for land, buildings, dormitories, workshops and hangars.

The 3500 air machines to be built in American factories this year will be used in the field by the forces to be trained at the nine camps.

Before any flying is attempted the student must take an 8-week course in the School of Military Aeronautics. The course includes military drill, calisthenics, machine gun, artillery observation, bombs and bombing, wireless and signaling, theory of flight, types of machines, care of machine, tools, map reading, reconnaissance, photography, stationary engines, motorology, cross country and general flying.

—

NEW YORK, May 21—The government will on May 1, 1918, take over the work of transporting the mail in this city. A private concern holds the contract now. It expires July 1 with the privilege of a 6 months' renewal.

England Adopts Ford Tractor

Ministry of Munitions Asks Cooperation in Building Standardized Product

DETROIT, May 23—The English Ministry of Munitions has adopted in its entirety the Ford tractor and is asking all manufacturers concerned to co-operate loyally in manufacturing the standardized products. Ford's engineers are under the direction of C. E. Sorensen, who is issuing blueprints to the different manufacturers with instructions to begin work on tractor production immediately. The War Agricultural Committee recommended the adoption of Ford tractors after testing them a week continuously day and night.

—

England Needs Tractors — Machines Rented to Farmers

LONDON, ENGLAND, April 20 — The farm tractor situation in England is not in as clearly a defined and satisfactory condition as the food problem would warrant it being in. The Government after rigorously excluding tractors has announced that until May 31 any one desiring may import unlimited quantities of them. Following this is what might be considered a joker that no supplies of gasoline can be furnished to those who purchase tractors. To this can be added the fact that the Government has commandeered a small number of tractors and is hiring them out at low rates to farmers requiring them. The result of this is that there is little incentive for the farmer to purchase tractors provided he can get his work done by the Government at a lower rate than would be possible were he to purchase machines direct. Unquestionably this situation will clarify itself in the near future. In the meantime it is certain that Great Britain is in need of tractors for more intensive farm cultivation.

—

Italy Helps Pay for Tractors

NEW YORK, May 18—The Italian Ministry of Agriculture has issued a notice fixing rules whereby agricultural bodies and societies in Italy may obtain a Government contribution toward the cost of acquiring tractors for mechanical plowing. The grant will be conceded to these bodies up to 30 per cent of the total cost. In the case of private persons the grant will not exceed 20 per cent.

—

Pa. Farmers Own 750 Tractors

HARRISBURG, PA., May 18—Approximately 750 tractors are now owned by Pennsylvania farmers on the farms throughout the several counties of the state, according to statistics gathered by the Pennsylvania state agricultural department. It is estimated that 250 tractors were sold by the various manufacturers last fall for spring delivery on Pennsylvania farms.

Statistics compiled by the crop reporters of the state department of agriculture throughout the state show that the largest number of tractors are owned by farmers in the rich agricultural counties of the state. When the census was taken last November the reporters in 704 townships of the state reported 250 tractors. This same ratio in the missing townships would make a total of more than 500, and the number sold last fall would bring the number now in use up to 750. The late fall, when the farmer receives his money for his crops, proves the largest buying season.

Lancaster County showed the largest number of tractors, the total being nineteen. Montgomery is a close second with sixteen tractors, and Lehigh County third with a total of fifteen. Other counties of the state at the top of the list are: Philadelphia, thirteen; Chester, twelve; Lycoming, eleven; Erie, nine; Westmoreland, nine, and York, eight. The report shows only about half a dozen counties of the state without any tractors on their farms.

—

Dodge-Ford Suit Open Again

DETROIT, May 22—The opening of the final hearing on the merits of the Dodge Brothers' suit against Henry Ford and the Ford Motor Co. took place yesterday in the circuit court in this city. The case, which has already been subject to much litigation over preliminary injunctions taken out by Dodge Brothers to restrain the Ford Motor Co. from carrying out certain expansion plans, bids fair to last a long time.

—

Rubber Assn. Forms Tire Division—Price Clause Favored

NEW YORK, May 19—A tire manufacturers' division of the Rubber Assn. of America is to be organized. Representatives of about forty of the principal tire companies approved such a move at a meeting held yesterday at their request.

The new division will be similar in organization and purpose to other existing divisions of the association, such as those including mechanical goods manufacturers and makers of rubber and fiber soles for shoes, etc. It will take up the problems peculiar to tire manufacture with a view to solving them in a manner acceptable to all. Formal organization probably will be completed in about 3 weeks.

H. S. Firestone, president of the association, presided at the meeting, which also went on record in favor of adopting a standard contract clause covering fluctuations in the prices of tires. This clause provides that if the manufacturer finds it possible to reduce prices to the dealer, he will give the dealer the benefit of the reduction; similarly, if the manufacturer increases prices, the dealer is to have the choice of accepting the balance of unfilled contracts at the advanced price, or of cancelling the balance of the contract.

Holley Vaporizers for England

Kerosene To Be Used in Ford Tractors—Devices Supplied at Cost to Government

DETROIT, May 21—The Holley Bros. Co. is arranging to establish a plant at Coventry, England, where it will manufacture kerosene vaporizers for Ford tractors at cost and without profit for the English government.

Arthur Dugrey, a member of the company, arrived at Coventry several days ago, and is now completing the arrangements which provide for production within the next 60 days.

The Holley Bros. Co. is making this move in harmony with the Ford Motor Co., which is now furnishing men, tools, and tractors to the British government at cost.

—

Russian Information Bureau Established in New York

NEW YORK, May 18—The Russian Information Bureau has been established in this city with offices in the Woolworth Bldg., under the direction of Prof. B. E. Shatzky and A. J. Sack. Its purpose is to furnish American interests with information in regard to industrial and commercial conditions in Russia.

—

Straits Settlements Prohibits Imports

WASHINGTON, May 21—The Straits Settlements has prohibited the importation of motor vehicles. The Department to-day published the following message from the American Consul General at Singapore:

"After May 16 the importation into this colony of automobiles, traction engines, and parts thereof is prohibited, except under Government license. In the federated Malay States a 10 per cent ad valorem duty on automobiles has been established."

—

Tractor Costs $350

TACOMA, WASH., May 21—Henry Korevaar, a farmer, has designed a tractor especially for use on the Pacific Coast where the excessive rains render many types of tractors useless. The tractor is supplied by an 8 hp. gasoline engine, will plow a 17-in. furrow 8 to 9 in. deep and has a harrow attachment behind. Its weight is about 1400 lb. and it can be manufactured for $350.

—

Brown Spring Oiler Issues Licenses

CLEVELAND, May 21 — The Brown Spring Oiler Co. has licensed the Babbitt Spring Oiler Co., the National Motor Supply Co., and the Lazarus Mfg. Co. to manufacture under one of its patents on spring leaf lubricators. Two other companies have agreed to do the same and the agreement will be signed up within a few days.

New Zealand Sales Increase

United States as an Ally Opens Up New Trade—Good Roads Coming

CHICAGO, May 21—New Zealand is buying American cars in larger quantities than ever before. Greater inclination is being shown toward American products than was true 2 months ago. They were then buying of a neutral; today they are buying of an ally. This is the substance of a statement made by J. B. Clarkson, managing director of Hope, Gibbons Sons & J. B. Clarkson, Ltd., Wellington and Christchurch, New Zealand, who is in America to purchase automobiles, motorcycles, accessories and tractors, which his company distributes in New Zealand and Australia.

New Zealand and Australia have one car for each 100 persons, approximately, and the ratio is the same in each country. New Zealand, with about 1,200,000 population, has about 12,000 cars, while Australia, with approximately 5,000,000 people, has about 50,000 cars.

Roads Improving

There has been a strong movement for better roads in this country in the last few years, especially since the automobile came into existence, and now the island may be traversed from north to south with little difficulty, although there are sections of the "bush," as the New Zealand thicket is termed, that are almost impenetrable. Motorists of this country know nothing of the taxation placed on cars in America. Naturally they have to pay high for American cars —a Ford there sells for between $900 and $1,000, and the cars that we can buy in the United States in the $1,000 class cost approximately $2,000 in the Antipodes. However, once a car is purchased, there is no further taxation. The high import duty and the high freight rates are looked upon by the commonwealth as sufficient for the car owner to pay. He gets a set of license plates for 60 cents, and that number is carried indefinitely. No one pays taxes in New Zealand except land owners. Personal property tax is unknown.

Traffic congestion has not made itself felt in New Zealand. Mr. Clarkson says he never saw a car in his country equipped with a bumper. English-made cars come into New Zealand under a 10 per cent import duty, while American cars carry a 20 per cent tax. Since the war, of course, there has been no importation of English cars because their production ceased. Mr. Clarkson says he now has orders for 1000 British cars for delivery as soon as possible after the war is over.

Some of the American car makers have their own branches in New Zealand, although there are a great many cars sold there by resident dealers. As might be expected, because of the high freight and import tax rate, our low-priced and medium-priced cars find the most ready market in New Zealand.

Mr. Clarkson made the statement that with the era of road-building coming strong in New Zealand and being conducted under scientific principles of engineering, he looks for sales of cars, especially American makes, to boom. Especially, he says, the tractor is finding its places in the fields.

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Michigan Beats 1916 Registrations

DETROIT, May 24—Michigan automobile registrations to date total over 177,000 as compared with 160,050 for the entire year 1916.

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Government Speakers at S. A. E. Dinner

NEW YORK, May 23—Col. Chauncey Baker of the Quartermaster Department and General Squires of the Signal Corps have accepted the invitation of the Society of Automotive Engineers to be present and address the engineers at their informal dinner at the New Willard Hotel, June 26. Secretary of War Newton Baker last week accepted the invitation.

It is expected that this dinner will be the largest get-together of the Government officials and S. A. E. members in the history of the society. Fully 800 are expected to attend. Over thirty guests representing the Army and Navy from Washington will be present, and in addition the Council of National Defense and other organizations co-operating with the Government at present are invited. Members are expected to make reservations through the New York office of the S. A. E. The dinner will be $6 per plate.

The majority of the papers to be read at the professional session June 26 have been decided upon. The speakers and their subjects were announced in THE AUTOMOBILE of May 17.

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General Motors Co. Transfer Approved

NEW YORK, May 23—Stockholders of the General Motors Co. of New Jersey yesterday approved the transfer of its assets and business to the General Motors Corp. of Delaware, and decided also to retire the $14,985,200 outstanding preferred stock of the company. The authorized preferred stock amounted to $20,000,000.

Prior to the meeting of the stockholders yesterday, an action, begun some time ago by Jacob Mayer, of this city, to prevent the transfer of stock, was settled out of court. Mr. Mayer, owning fifty shares of the preferred stock, objected to the transaction on the ground that the preferred stock owners would not be benefited by the change.

The Delaware corporation has a total authorized capital stock amounting to $102,600,000. As told in these columns, holders of the old preferred receive one and one-half shares of 6 per cent preferred in the General Motors Corp. for each share of 7 per cent stock owned. The old preferred to be retired is the stock which will not be exchanged for the new preferred.

Six Clydesdale Truck Models

Clyde Cars Co., as Result of Recent Merger, Will Concentrate in Clyde, Ohio

NEW YORK, May 21—The Clyde Cars Co., formed as a result of the recent merger of the Krebs Commercial Car Co., the Clyde Cars Co., Clyde, Ohio, and the Lincoln Motor Truck Co., will produce six models, including 5, 3½, 2, 1½, ¾ and 1-tonners. As was announced last week, these trucks will be known under the name of Clydesdale.

Clydesdale trucks were originally designed by European engineers to conform as closely as possible to the requirements of French and English war office specifications, as was possible with the use of American components. The company has been doing a large export business with the English and French governments in its 2 and 3½-ton models.

As a result of the merger, the capital has been increased to $500,000 so as to take care of an enlarged production.

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To Develop Airplane Mechanics

DETROIT, May 24—The Government has asked all automobile factories for the names of their most expert mechanics. About 100 will be sent to France to gain experience in airplane construction and later will return to develop this work here.

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Airplane Factory at Joy Field

DETROIT, May 24—The Government plans to erect a big shop for making airplanes and also an aviation school on Joy Field, which was transferred to the Government at cost by H. B. Joy, yesterday.

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DETROIT, May 24—The Patterson Aeroplane Co., being formed here, has secured a factory and expects to start on Government work in the near future.

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Electrical Interests Hold First Annual Meeting

HOT SPRINGS, VA., May 19— To-day marked the closing of the first annual meeting of the Automotive Electric Assn., at the Homestead Hotel, this city. The 3-day session was attended by approximately forty from the eleven company members.

O. F. Conklin, Remy Electric Co., chairman of the standardization committee, made his report, appointing various sub-committees to handle various subjects of importance in the industry. A sub-committee has been appointed to handle the work in connection with supplying the government with electrical equipment for use on trucks and airplanes.

Efforts were made at this meeting to arrange some manner in which the patent situation pertaining to the industry

could be amicably adjusted to the best interests of its members and their customers. A preliminary investigation shows prospect of serious and extensive litigation involving many companies.

This association was formed last April and is composed of manufacturers of automotive electric accessories, as follows:

Dayton Engineering Laboratories Co., Dayton.
Dyneto Electric Corp., Syracuse, N. Y.
Electric Auto Lite Co., Toledo.
The Leece-Neville Co., Cleveland.
North East Electric Co., Rochester, N. Y.
Remy Electric Co., Anderson, Ind.
The Robbins & Myers Co., Springfield, O.
Splitdorf Electric Co., Newark, N. J.
U. S. Light & Heat Co., Niagara Falls, N. Y.
Wagner Electric & Manufacturing Co., St. Louis, Mo.
Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa.

G. B. Griffin of Pittsburgh is president; C. O. Mininger of Toledo is vice-president; G. S. Cole of Cleveland is secretary; and C. L. Amos of Syracuse is treasurer.

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Gear Assn. Holds First Convention

PITTSBURGH, PA., May 21—The first convention of the recently organized American Gear Manufacturers' Assn. closed last week in this city at the Hotel Schenley, after a 2-day session. The convention was opened by F. W. Sinram of the Van Dorn & Dutton Co., Cleveland. Several important papers of interest to the gear manufacturers were read. S. L. Nicholson, sales manager of the Westinghouse Electric & Mfg. Co., spoke on the Ins and Outs of an Industrial Organization, and J. E. Gleason read a paper on The Spiral or Curved Tooth Bevel Gear. Frank Burgess presented a paper on Job Gearing—To What Extent Can It Be Standardized, and William Ganschow presented a paper on Advantages of Gear Standardization. G. L. Markland discussed the Difficulties of Gear Standardization.

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WAUKESHA, WIS., May 23—Mitchell Mackie, sales manager of the Waukesha Motor Co., has been called to the front as captain of a truck squadron.

Sales Decline in Argentina

Failure of Makers to Supply 60-In. Treads and Magnetos Restricts Market

BUENOS AIRES, April 10—Winter is now coming on in Argentina, which means the slowing up in the sale of automobiles, and while there is never snow in this city it gets very cold during June and July, which are the winter months. There is frequently ice on small pools and automobile sales correspondingly slow up.

The automobile industry is not in the best of condition, and has been suffering for a year because of poor crops and distress brought about by the exceptionally cold winter a year ago. In Argentina the camp, or country, represents 80 per cent of the automobile purchasing power of the country. The buying capacity of the camp, or country, depends largely on the wheat crop, maize crop and road improvement. Last year there was a great shortage of the wheat crop due to the prolonged drought and locust troubles. In spite of this there was good selling of automobiles, and those dealers who had quantities of cars on hand had no difficulty disposing of them. One dealer representing a large U. S. A. producer sold over 300 cars in practically 2 months. He was fortunate in having a large stock on hand ready for delivery.

Argentina is rather uncertain as to what the entry of the U. S. A. into the war will mean so far as the automobile industry is concerned. Dealers here are wondering if export of automobiles will be cut down owing to automobile factories being requisitioned by the Government for the manufacture of munitions. It is expected that reduced shipping facilities and higher war and insurance lists will have their effect on limiting exports.

Dealers here are indulging in much speculation as to whether the U. S. A. manufacturers, who, since the war, have become the sole purveyors of this market, will be able to hold the trade after the war. Gossip among dealers here to this effect is largely based on the fact that American manufacturers refuse to believe that automobile requirements here are any different from those in the United States. It is getting generally understood that American manufacturers will not continue to supply cars with 60-in. treads and the dealers look upon this as one more example of the tendency of American manufacturers to self-glorification. Some dealers consider that the refusal to supply 60-in. treads is equivalent to American manufacturers voluntarily relinquishing the hold they have on this market.

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Pierce-Arrow 4-Mo. Profits $1,341,132

NEW YORK, May 23—Operating profits of the Pierce-Arrow Motor Car Co. for the 4 months ended April 30, after deducting all expenses and accrued taxes, except tax on excess profits, amounted to $1,502,833. Net profits for this period were $1,341,132, after deducting $5,257 interest charges and $156,444 for depreciation of plant and equipment. The company estimates excess profits tax at approximately $73,000 for the 4 months, basing this figure on existing laws, but has made no reservation in respect to proposed taxes now under discussion.

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Expects Postal Rate Increase Defeat in Senate

WASHINGTON, May 23—Defeat in the House of an amendment under which the proposed increase on rates of second class mail matter would have been eliminated will not serve to check the fight which publishers of the country are making against this proposition of the war revenue bill.

On the other hand, the fight has been transferred to the Senate, where prospects are good for the ultimate defeat of this entire section.

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485,629 Fords in 9 Months

DETROIT, May 23—Frank Klingensmith, of the Ford Motor Co., to-day testified in the Dodge-Ford suit that 485,629 Ford cars were sold from Aug. 1, 1916, to April 30, 1917, at a profit of $21,520,633.50. John F. Dodge denied that he threatened Ford for refusal to buy his holdings in the Ford company for $30,000,000.

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Oppose Illuminated License Plate Bill

ALBANY, N. Y., May 23—The Ottinger bill, requiring illumination of automobile license plates, is in the hands of Governor Whitman, having passed both Houses last week. This bill is opposed by the automobile interests on the ground that it would place a monopoly in the hands of the owner of the patent. Charles Thaddeus Terry, representing the Automobile Dealers' Assn., is fighting the bill.

Officers of the American Gear Manufacturers' Assn. Left to right—F. W. Sinram, Van Dorn & Dutton Co., Cleveland, president; Frank Horsburgh, Horsburgh & Scott, Cleveland, treasurer; F. D. Hamlin, Earle Gear & Machine Co., Philadelphia, secretary; and H. E. Eberhardt, Newark Gear Cutting Machine Co., Newark, N. J., vice-president

Personals

DETROIT, May 18—D. McCall White, formerly chief engineer of the Cadillac Motor Car Co., who has just resigned that position, will temporarily do consulting work and also engage in research work on aeronautic engines. Mr. White, while temporarily in the consulting field, is negotiating for other connections where his experience in engine design will be of value. He was formerly chief engineer of Alley & McLellan, Ltd., Glasgow, Scotland, builders of high-speed engines and air compressors, and at other times chief engineer of the All British Motor Car Co., Ltd., Glasgow, Scotland; chief engineer of the Naples branch of the Daimler Motor Car Co., Coventry, England, where he designed the first Knight 22 hp. cars which won the Dewar trophy in England. Mr. White was also chief engineer and works manager for D. Napier & Son, Ltd., London, England, and manager of the Crossley Motors, Ltd., Manchester, England, whence he came to the United States as chief engineer of the Cadillac Motor Car Co., where he did the pioneer and designing work on the eight-cylinder Cadillac.

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NEW YORK, May 23—V. W. Kliesrath, who has been chief engineer of the Bosch Magneto Co. for a great many years, and who is as well known in connection with the magneto business as any man in America, has handed in his resignation to take effect in the near future. Mr. Kliesrath has had a very wide experience with the Bosch company, having been directly in charge of the main office and also having control of the engineering and technical department. In addition to handling the automobile end, he has handled the motor boat and aeronautical work as well. At present Mr. Kliesrath has no plans for the future further than a short vacation.

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DETROIT, May 19—C. T. Myers, who has been doing consulting work with the Government in connection with the drafting of the specifications for the war department trucks, is having several calls from transmission, axle and truck manufacturers for information as to methods of procedure in meeting the Government requirements for the tractive factor.

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DETROIT, May 21—Lowell C. Freeman has been appointed chief engineer of the Fuller & Sons Mfg. Co., Kalamazoo, Mich., transmission maker. Mr. Freeman was formerly chief engineer of the Denby Motor Truck Co.

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NEW YORK, May 19—Mathew Farrell, New York representative of the Duplex Engine Governor Co., as sales engineer, has been ordered to Fort Sam Houston, San Antonio, Texas, as captain of the Quartermaster's Department, of the Officers' Reserve Corps, in the army transport and similar motor truck service work.

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ST. LOUIS, Mo., May 21—G. M. Bicknell has been appointed sales engineer of the Carter Carburetor Co. of St. Louis, with entire charge of the factory sales in and around Detroit and of all of the company's engineering work in the field.

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TOLEDO, May 19—H. G. Fides has been appointed director of service of the Willys-Overland Co. K. R. Jacob, formerly service manager, has been appointed assistant sales manager.

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CHICAGO, May 19—W. G. Gernandt, formerly of W. G. Gernandt & Co., consulting engineers, Detroit, has opened an office here for automotive engineering consultation.

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INDIANAPOLIS, May 21—Joseph Ward has been made district manager of the United States Tire Co., with headquarters here. He formerly was connected with the Waverly company, served as assistant sales manager of the American Motors Co., and in 1915 became a special factory representative and later local branch manager of the United States Tire Co. He will now have supervision over three branches, Terre Haute, Fort Wayne and Indianapolis.

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DETROIT, May 21—F. B. Clark has been promoted to general supervisor of districts for the Scripps-Booth Motor Car Corp.

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YORK, PA., May 17—B. P. Y. Jordan has become managing director of the sales of the Bell Motor Car Co. H. F. Gundrum is in charge of the service department.

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CLEVELAND, May 17—F. E. Sangbush has resigned as sales manager of the Abbott-Detroit Motor Car Co. to become sales manager of the Columbia Motors Co.

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DETROIT, May 21—C. E. Callender, who was secretary of the Olympian Motors Co. of Pontiac, is now the president of the Olympian Motor Sales Co. of Chicago.

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PITTSBURGH, May 19—W. H. Allen has been appointed local sales representative of the United Smelting & Aluminum Co., New Haven, Conn.

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DETROIT, May 22—William T. Brush, assistant sales manager of the Studebaker Corp., has resigned and has purchased a one-half interest in the Philadelphia Sales Corp., distributors of Studebaker cars.

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DETROIT, May 21—G. A. Holder has been appointed general auditor of the Harroun Motors Corp. Mr. Holder was formerly special auditor for the Maxwell Motor Car Co.

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DETROIT, May 21—C. F. Clark, who for several years has been general manager of the Michigan Electric Welding Co. and a director of the Steel Products Co. of Cleveland, has resigned to become a member of the officers' reserve corps.

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NEW YORK, May 18—M. R. McAdoo, Jr., and W. A. Coleman, both of the sales department of the Chevrolet Motor Co., and M. J. Corray, of the material department, have gone to Plattsburg as members of the Officers' Reserve Corps.

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NEW YORK, May 19—A. C. Bagby has become credit manager of the recently formed credit department of the Motor and Accessory Manufacturers. Mr. Bagby is credit manager of the Hess-Bright Mfg. Co., Philadelphia. He will be in charge of the work of enlarging and extending the credit service of the association.

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NEW YORK, May 21—L. W. Kennedy has become special truck tire representative of the United States Tire Co. in the Southern District. His headquarters are in Atlanta.

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DETROIT, May 21—F. W. Hughes has been appointed production manager of the Indiana Motor Truck Co. at Marion, Ind. Mr. Hughes was formerly Detroit resident engineer for the Covert Gear Co.

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CINCINNATI, May 21—Martin Murray is now in charge of the sales organization of the Corcoran Mfg. Co.

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ELECTIONS

DETROIT, May 21—Frank M. Eldredge has been elected secretary and treasurer of the Wallace C. Hood Service Bureau. Mr. Eldredge will continue as director of advertising and publicity of the company.

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ST. LOUIS, Mo., May 8—E. O. Paterson has been elected president of the Hudson-Phillips Motor Car Co., of this city, succeeding John H. Phillips, who recently resigned. Mr. Phillips was formerly district manager for the Hudson Motor Car Co. of Detroit, and was connected with that company for 6½ years.

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DETROIT, May 21—Herbert D. Allee has been elected assistant-treasurer and comptroller of the Hayes Mfg. Co.

Factory Activities

INDIANAPOLIS, IND., May 21 — The Mills Electric Co., Lafayette, will manufacture a light electric motor-driven car to be used on boardwalks and at pleasure resorts. The company has a capitalization of $100,000, with the following directors: Byron J. Mills, Herbert A. Keller and Eldon L. Lewis.

In addition to making a car for use at summer resorts, the company expects to find a market in providing light cars for women and especially designed electric cars for invalids. The motor will develop 3 hp., the battery being concealed under the seat, the motor being under the hood. The car will have a canopy type and side curtains for use in bad weather. The company says it has orders for 100 cars this summer, and expects to sell 200 this year.

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AKRON, May 21—The Goodyear Tire & Rubber Co. is providing interchangeable wheel sets accommodating tires of the no hook type. Owners of cars wearing regular clincher rims taking 30 and 31 in. tire sizes may now have greater facility in tire changing and also use Cord tires. These wood wheels, made of straight grain hickory, come in size 30 by 3½. The original hub plates and bearings are used.

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BRIDGEPORT, CONN., May 19—The Connecticut Auto Mfg. Co. will build a four-story factory, 70 by 128 ft.

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READING, PA., May 17—The Hahn Motor Truck & Wagon Co. will build the first unit of its factory building. This will be known as the chassis assembling building 52 by 192 ft.

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KALAMAZOO, MICH., May 19—The Fuller & Sons Mfg. Co. has let its contract for a new heating plant. The new four-story factory building is progressing and is now up to the third floor.

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MILWAUKEE, WIS., May 17—The Clum Mfg. Co., maker of automobile and truck switches, has moved into a new factory at 23-25 Erie Street. This company also makes other electrical specialties. The new plant will give it four times its former space.

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CANTON, OHIO, May 19—The Canton Motor Co. offered the use of the roof of its new building as a drill ground for the use of the Canton unit of the new 10th Ohio regiment being organized here.

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ST. LOUIS, MO., May 21—The plant of the Macon Motor Car Co. at Macon, Mo., was totally destroyed by fire Thursday morning. The loss is placed at $225,000. On Friday the attorney for the company asked that a receiver be appointed. The assets listed in the application were: Uncollected insurance, $17,500; factory site, $2,500 and prospects of a suit against the Wabash railroad, since the factory is alleged to have caught fire from burning railroad property.

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RACINE, WIS., May 19—The Racine Motor Truck Co., organized several weeks ago to establish a plant for the manufacture of motor trucks, has completed its organization and is ready to proceed with its plans. Ira L. Miller has been elected president. B. F. Henline, Gibbon, Neb., until now cashier of the Commercial Bank of Gibbon, has been elected secretary and treasurer.

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PEORIA, ILL., May 21—Negotiations are under way between residents of East Peoria and representatives of the Lambert-Multiplus Co., Portland, Ore., for the erection of a plant to manufacture tires. It is desired to establish an eastern branch of the main plant.

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NORWALK, OHIO, May 21—The Norwalk plant of the Crucible Steel Co. is being enlarged by the addition of machinery and buildings and will employ 300 more men.

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MOLINE, ILL., May 21—The Moline Plow Co. has let the contract for the erection of an addition to the tractor plant to Stone & Webster of Chicago. The addition will be 100 by 750.

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PITTSBURGH, May 19—The United States Wire Tire Co. will build its plant in this city. This company manufactures a solid tire which is guaranteed for 12,000 miles. The steel spring construction gives a tire that is equally resilient with each of the other three of its set.

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MILWAUKEE, WIS., May 19—The Western Fixture Co., Milwaukee, Wis., which operates one of the leading welding and cutting shops specializing in automobile work in Wisconsin, has moved to its new machine shop and manufacturing plant at Humboldt and Concordia Avenues. The factory will enlarge its production of display fixtures, racks, stands, etc.

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EAU CLAIRE, WIS., May 19—The Gillette Rubber Co., manufacturer of Gillette safety tires, is now engaged in a regular production in its new plant, erected at a cost of more than $100,000. The company has gathered an ample supply of raw materials for a large output and is assured of future supplies. The equipment is designed for the production of tires by the so-called chilled rubber process, a secret formula compounded by its own chemists and used exclusively in the manufacture of Gillette tires. A sales office has been established at 1834 Broadway, New York, and the Chicago office is located at 182 South Michigan Avenue.

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EAST KEYPORT, N. J., May 21—The Aeromarine Plane & Motor Co. has commenced the installation of machinery at its new plant. The initial works comprise an area 150 by 300 ft., and will be used for the manufacture of seaplanes.

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FLEETWOOD, PA., May 19—The Fleetwood Metal Body Co. is having plans prepared for a three-story addition, 60 by 125 ft.

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EVANSVILLE, IND., May 21—Graham Bros. announce that their supply of raw materials has been nearly all delivered. This company manufactures the Graham Bros. 1-ton truck unit selling at $385. As a result of the material on hand the company is prepared to make prompt deliveries.

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MINERVA, OHIO, May 19—The Specialty Manufacturing Co. has had on the market a headlight tilter which is said to comply with the state and city laws. It enables the driver of the car by pressure of the foot to depress the lights for city driving and also with a very slight movement of the foot to elevate the lights for country driving. It was invented and manufactured by P. L. Pennock, a banker.

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AURORA, ILL., May 21—The Lumb Motor Truck & Tractor Co. turned out the first completed truck this week. The first model has a 2-ton capacity and weighs 5400 lb. It is equipped with a 37 hp. Buda engine of four cylinders and has a number of new features.

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DETROIT, May 21—The Covert Gear Co. has taken over the former plant of the Gray Motor Co., which has a floorspace of 56,000 sq. ft., and will use this factory to manufacture, in Detroit, about twice as many transmissions as are made in the Lockport, N. Y. factory.

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GREENVILLE, MICH., May 19—The Tower Motor Truck Co. has started operations in its new plant and expects to be turning out 100 trucks this year. The building is 60 by 220.

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FLINT, MICH., May 21—The Champion Ignition Co. has placed an order for automatic screw machinery amounting to $50,000. This is additional to several orders recently placed for other machinery.

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NILES, OHIO, May 19—The Niles Car & Mfg. Co. is continuing the manufacture of 1 and 2-ton worm-driven trucks and in a short time will have a 3½ and

5-tonner on the market. On May 1 this company adopted a new sales plan. No sales will be made from the factory direct to the consumer, except through their agents.

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DETROIT, May 21—The Edmonds & Jones Corp. is enjoying a rapidly increasing business. The use of farm tractors by night has resulted in large numbers of orders for lamps.

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LANSING, MICH., May 21—The Dail Steel Products Co. is erecting a new factory addition and office building. The company was recently recapitalized for $100,000. It will make accessories.

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INDIANAPOLIS, IND., May 21—Striking workmen are gradually returning to work in the automobile and automobile parts manufacturing plants at Muncie, where 3000 machinists walked out 2 weeks ago when they were refused an 8-hr. day, a 20 per cent increase in wages, recognition of the union, and time-and-a-half for overtime.

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DETROIT, May 22—The Chalmers Motor Co. of Canada has ordered construction of a new building adjacent to the remains of the factory which recently burned. The structure will be 325 ft. long and will cost $25,000.

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EAST PALESTINE, OHIO, May 19—A strike at the plants of the McGraw Rubber Co. and the National Tire & Rubber Co., both located at East Palestine, caused both concerns to shut down indefinitely. The tire builders and vulcanizers demand higher wages and better working conditions. In all about 1600 men are idle as a result of the strike. The manufacturers have been in conference with committees from the workers, but no settlement is yet in sight.

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LANSING, MICH., May 22—The Lansing Stamping & Tool Co., which makes parts for Reo and Chevrolet and other cars, is building an addition to its plant. The new building will be 66 ft. by 320 ft.

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Bimel Co. Plant Is Sold

SIDNEY, OHIO, May 21—The American Motors Parts Co. of Indianapolis has purchased the stock, machinery, and so forth, excepting the finished cars, of the Bimel Automobile Co. of this city, at the Bimel auction sale. The American Motors Parts Co. bid $15,715.

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PRODUCTION

BRIDGEPORT, CONN., May 21—The total number of automobiles and trucks delivered by the Locomobile Co. of America to date this year shows an increase of 34 per cent over the total deliveries a year ago.

Orders now being received are normal. The company has many orders in hand, sufficient to run the plant for a long time.

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ELKHART, IND., May 21—The Crow-Elkhart Motor Co. has increased its production to 1000 cars a month. This is more than double its output a year ago.

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AKRON, OHIO, May 19—The B. F. Goodrich Co. tire department is producing close to 30,000 tires a day. As a result this department is working on a 24-hr. day schedule. Continuous relays are run from Sunday midnight until midnight Saturday.

Earnings of the company are running about even with a year ago. For the 12 months ended Dec. 31, 1916, net was equal to $12.76 a share for the $60,000,000 common, after the preferred dividends, as compared with $17.17 a share in 1915 and $5.50 a share in 1914.

The expansion program has been completed, and there is little likelihood of any further heavy expenditures for plant additions for some time.

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LANSING, MICH., May 22—The Reo Motor Car Co. manufactured 15,055 passenger cars and 4566 trucks from Jan. 1 to April 18.

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SYRACUSE, N. Y., May 21—The H. H. Franklin Mfg. Co. increased its shipments 140 per cent during the 6 months ended April 30. In spite of the increased production the company has two and one-quarter times as many unfilled orders on hand as was the case at this time last year.

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Enger Plant Sale Postponed

CHICAGO, May 22—Sale of the assets of the Enger Motor Car Co., which was to have been auctioned May 24 and 25 at Cincinnati by Samuel L. Winternitz & Co., Chicago, has been postponed to June 5. Everything is to be sold, including the real estate, and the inventory value is given as $500,000. The plant may be inspected on and after June 1 and it is expected the sale will be consummated in 2 days. Tools and machinery of each department will be sold in separate parcels.

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Steel Situation Is Still Uncertain

Trade Is Waiting on Developments at Washington

NEW YORK, May 23—At the time of writing the steel trade is still waiting on Washington, is still uncertain what action the Government is going to take; consequently the whole steel situation remains as uncertain as it has been for the last 2 weeks. Little by little the requirements of the Government are being indicated, but till these are fully announced there can be no certainty as to the supplies which will be available for other users. Meanwhile prices, for whatever they represent at the moment, have been rising. Bessemer pig iron has been sold in Pittsburgh for $48; foundry grades of ore stand around $43 for 1917 and 1918 deliveries. Steel prices, of course, follow iron, soft steel bars commanding $95 and even $100 for immediate delivery.

An effect of the American credit established for the Allies is seen in increasing inquiries from abroad, but ports are already congested with steel products awaiting bottoms for transporting them to Europe. It is obvious that America will have, if possible, to supply very large quantities of railroad material for reconstruction in France and probably in Belgium also at a later date. More and more steel will be shipped out of the country as the facilities for ocean transportation increase. If they are to continue to handle freight at the present high pressure the American roads must also have much new equipment, especially rails.

Among metals, copper has suffered most from recent submarine sinkings; thousands of tons now lying at the bottom of the Atlantic that ought to be in the munition factories of England and France. The most urgent thing just now is to replace these losses with all speed. Present exports are at the rate of over 1,000,000,000 lb. per year. It is now thought that government purchases will be made at approximately market prices instead of fictitious ones which are expected to be to the advantage of other consumers.

In spelter the price has not risen so fast as expected. Zinc ore producers feel that the temporary check due to entrance of the country into war is passing and that industries will increase demand for spelter. They had generally expected to sell zinc ore at $5 advance the past week, but the sales showed only $2.50 advance on the medium grades, while best grades were firm at $80. Sales were between $75 and $80, with basis quotations $70 to $80. Some producers are said to have held over their ore for a further rise.

It seems that the leather shortage is re-acting upon tire prices, in that the demand for fabric belting is increasing. Tire makers are suffering from shortage of cotton and also shortage of textile facilities for weaving the required grades of fabric. Movements are on foot to increase fabric production and it is stated that one firm, the Towar Cotton Mills, Niles, Mich., is installing equipment to turn out 1,000,000 lb. of tire fabric annually.

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DETROIT, May 24—H. G. Stewart, service manager of the Chalmers Motor Co., has been appointed service manager of the New York branch.

Detroit Purchasers To Meet

Permanent Organization to Be Effected May 24—500 Agents Are Invited

DETROIT, May 18—At a meeting of the governing committee of the Detroit Section of the National Assn. of Purchasing Agents, it was decided to call a general meeting for Thursday, May 24. This will be held at the Hotel Statler, Detroit, at 8 p.m. About 500 purchasing agents representing various industries in this territory have been invited to attend. It is probable that E. L. McGrew, president of the national organization, will be invited to be present to address the meeting, when a permanent organization will be effected.

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Gasoline Higher in Denver

DENVER, COL., May 18—The price of gasoline has jumped another cent in Denver after remaining steady 4 months. The wholesale price now is 23 cents to filling stations and garages, where it retails at 25 cents. Some garages charge 1 to 3 cents more, claiming that they sell gasoline merely as an accommodation and cannot afford to handle it at the filling station margin. The tank wagon price direct to consumers in lots of 25 gals. or more is 24 cents. There were two 1-cent advances in January. The only reason given for the higher price is increased demand.

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PITTSBURGH, PA., May 19—The Manchester Auto & Machine Co. plans to erect a three-story addition 100 by 130 ft., to cost $50,000.

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Nuoline a Gasoline Substitute

NEW YORK, May 19—Experiments are being made at the West Side Y. M. C. A. Automobile School with a new automobile fuel called Nuoline, put forth as a substitute to sell at 10 cents a gallon. Louis Clemont, the inventor, a Danish chemist, says the ingredients are cheap and that two-thirds of the liquid is water.

Tests of the liquid, which is a milky white, have shown it as an able substitute for gasoline. A road test of 415 miles has just been completed, a car having been run to Albany on the east side of the Hudson, and then to Schenectady and Utica, returning on the west side of the river via Newburgh and the Fort Lee ferry. The average was 11 m.p.g. Other tests have shown a smoother running engine.

Response to the accelerator with Nuoline was much better than with gasoline. There was none of the gasoline fumes from the exhaust, but a faint odor of camphor, which was explained to be coal camphor from one of the ingredients used in the manufacture of the fuel.

A company is being organized to manufacture Nuoline commercially. The president will be Senator Robert Lawson of Brooklyn. Associated with him will be H. C. Brokaw, M. Clemont, Dr. H. O. Lehman and H. Boes.

—

Doble Stock Offered at $11

DETROIT, May 22—The Doble-Detroit Steam Car Co., which was organized recently as told in a past issue of THE AUTOMOBILE, has undertaken to place its $10,000,000 capital in common stock in the hands of investors through its own organization at $11 a share.

—

Equipment and Other Car Changes

NEW YORK, May 21—Several changes in equipment have been made during the last few weeks by the automobile makers. Locomobile is now using the Berling magneto. Marmon has changed from the 34 by 4½-in. tire to 32 by 4½. Partin-Palmer has added two new models to its line known as Ultra-4-Forty five-passenger touring car at $885 and the Ultra-4-Forty Chummy roadster at $895. The chassis of these two models are the same as the model 32.

—

CHANGES IN PRICES

Car	Model	Old Price	New Price	Effective
Velie, 28	Coupe	$1,750	$1,800	.....
Velie, 28	Sedan	1,685	1,735	.....
Jeffery, 4	Det. Top	1,260	1,320	.....
Jeffery, 6	Det. Top	1,630	1,690	.....
Westcott,	Sedan	2,290	2,390	.....
Chandler, 7-Pas.	Tour.	1,395	1,595	June 30
Chandler, 4-Pas.	Rdstr.	1,395	1,595	June 30
Chandler, 7-Pas.	Con. Sedan	2,095	2,295	June 30
Chandler, 4-Pas.	Con. Rdstr.	1,995	2,195	June 30
Chandler,	Limousine	2,695	2,895	June 30

Daily Market Reports for the Past Week

Material	Tues.	Wed.	Thurs.	Fri.	Sat.	Mon.	Week's Changes
Aluminum, lb.	.60	.60	.60	.60	.59	.59	— .01
Antimony, lb.	.25	.25	.25	.25	.25	.25	...
Bessemer Steel, ton	80.00	80.00	85.00	85.00	85.00	85.00	+5.00
Copper, Elec., lb.	.32	.32	.32	.32	.32	.32	...
Copper, Lake, lb.	.32	.32	.32	.32	.32	.32	...
Cottonseed Oil, bbl.	16.35	16.30	16.25	16.40	16.50	16.40	+ .05
Fish Oil, Menhaden, Brown, gal.	.80	.80	.80	.80	.80	.82	+ .02
Gasoline, Auto, gal.	.24	.24	.24	.24	.24	.24	...
Lard Oil, prime, gal.	1.85	1.85	1.90	1.90	1.90	1.95	+ .10
Lead, 100 lbs.	9.50	9.50	10.00	10.00	10.00	10.00	+ .50
Linseed Oil, gal.	1.27	1.27	1.27	1.27	1.27	1.27	...
Open-Hearth Steel, ton	80.00	80.00	85.00	85.00	85.00	85.00	+5.00
Petroleum, bbl., Kans., crude	1.70	1.70	1.70	1.70	1.70	1.70	...
Petroleum, bbl., Pa., crude	3.10	3.10	3.10	3.10	3.10	3.10	...
Rapeseed Oil, refined, gal.	1.40	1.40	1.40	1.40	1.40	1.40	...
Rubber, Fine Up-River, Para, lb.	.76	.76	.76	.76	.76	.76	...
Rubber, Ceylon, First Latex Crepe, lb.	.85	.85½	.85½	.84½	.84½	.84½	— .00½
Sulphuric Acid, 60 Baume, gal.	1.50	1.50	1.50	1.50	1.50	1.50	...
Tin, 100 lb.	66.25	66.25	66.00	65.00	63.75	65.25	—1.00
Tire Scrap, lb.	.06½	.06½	.06½	.06½	.06½	.06½	...

Steamotor Truck Co. Formed

Will Use Doble Equipment—Plan 150 Trucks Daily—Other New Firms

CHICAGO, May 21—The Steamotor Truck Co., with a capital of $3,000,000, has been formed in this city to manufacture steam motor trucks using the Doble equipment. The company has been licensed under the Abner Doble patents.

Manufacturing arrangements have been made on a scale contemplating the production of 150 trucks per day.

—

PROVIDENCE, May 21—The Auto Parts Co., manufacturer of a large line of car specialties, will change its name on June 1 to Apco Mfg. Co. Inc. The company has been marketing goods under the trademark Apco for some time. Capitalization of the company will be increased from $30,000 to $200,000.

—

LAFAYETTE, IND., May 21—The equipment and patent rights of the Bucrum Mfg. Co., Peru, have been purchased by W. S. Crum and will be moved here. The company makes a tire carrier for Fords.

Under the new policy this carrier will be manufactured so that it can be attached to any car.

—

DETROIT, May 21—The Armored Motor Co. has been incorporated for $100,000. Incorporators include W. A. Ross, Webb C. Artz and A. Lester Nancourt.

—

DETROIT, May 21—The Progress Auto Equipment Co. has been formed here with a capital of $50,000. Incorporators are: Carl Torgl, O. H. Schnepper and Herman A. Schmidt.

—

DOVER, DEL., May 21—The Preston Motor Car Co. has been formed to manufacture engines of all kinds. The capital is $10,000,000 and the incorporators are K. E. Longfield and F. D. Buck.

—

INDIANAPOLIS, IND., May 21—The Security Tube Co., South Bend, has been formed, with a capitalization of $150,000, to manufacture tires and tubes. The following are directors: William P. Furey, Rae C. Blackmun, Joseph W. McInerny, H. H. Haverstock and Hugh B. McVicker.

—

CANTON, OHIO, May 8—The Canton Rim Co. has been formed here with a capital of $100,000. William P. Beardsley, A. R. Turnbull, Henry R. Bauhof, Grover C. Allison, John G. Smith, and Thomas Llewellyn, Jr., are the incorporators.

—

MILWAUKEE, WIS., May 19—W. A. Ziola, formerly of Madison, Wis., inventor of a number of new electrical de-

vices, including magnetos, coils, X-ray machines and electro-therapeutic devices, has enlisted capital in Milwaukee for the establishment of a factory. The business has been incorporated with a capital stock of $20,000, and the organizers include Mr. Ziola, Dr. Theodore H. Rolfs and E. W. Bentzien. Definite arrangements for productive facilities are now being made.

—

DESHLER, NEB., May 18—The Deshler Auto Spring Wheel Co. has been organized here with a capital of $100,000. The organization will manufacture a steel spring automobile wheel patented by W. Nance, a machinist, who is president of the company. Gregor Langs is vice-president, H. Schlamann, secretary-treasurer, and H. J. Struve, director.

—

COLUMBUS, OHIO, May 18—The Columbus Climax Rubber Co. will locate its plant in this city. The company is capitalized at $200,000. I. S. Hoffman is president and associated with him are R. C. Wilson, managing the Columbus Cadillac Co.; H. H. Copeland, U. S. Brandt, and A. W. Beatty. Its offices are in the Citizens Bank Building.

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Monitor Offers Stock to Public

COLUMBUS, OHIO, May 18—The Monitor Car Co., which makes four and six-cylinder cars, is offering for sale a large block of preferred stock of the company. The concern is capitalized at $1,000,000. It is the plan to use the money secured from the sale of stock for enlargements and additions to the plant. Recently the company closed deals for the sale of a large number of cars to Norway, Sweden and Denmark.

Further Declines in Securities

Little Buying — Liquidation General—High Prices of Materials Important Factor

NEW YORK, May 22—Automobile and accessory issues were weak again last week. Buying was chiefly from the short interest and from a few hardy traders who hoped to pick up a point or two on a rally. The upward march of steel prices, leather, brass, copper, rubber, in fact in everything that enters into the manufacture of a car, has curtailed demand for automobile stocks. The 5 per cent tax is also held by the short interests as a trump card for their manipulations.

Willys-Overland has reached a new low of 26⅛ on its common. Studebaker common has dropped to 80¼, a loss of 7½ points. Saxon is down 7¼ points to 36, and Chandler has dropped to 86, a loss of 4½ points, and General Motors has reached 102¼, a drop of 3⅛ points.

—

Goodyear April Sales $10,000,000

AKRON, May 21—The Goodyear Tire & Rubber Co. had sales in April amounting to more than $10,000,000. Sales in April of 1916 were $6,519,672.15. Sales in April, 1915, were $4,048,352.78.

—

Chandler Sales Gain 134 Per Cent

CLEVELAND, May 23—The Chandler Motor Co. increased its business 134 per cent from Jan. 1 to May 1, over the same period last year. Profits increased 182 per cent. Net profits of the company up to June 1 partly estimated, were equal to slightly better than $17 a share.

—

Keystone Tire Earns $75,000

ERIE, PA., May 21—The Keystone Tire & Rubber Co.'s net earnings for the month of April amounted to approximately $75,000, a record.

—

Changes of Capital

DETROIT, May 21—The Metal Mfg. Co. has increased its capital from $10,000 to $100,000.

—

ROCHESTER, N. Y., May 18—The Unitube Auto-Radiator Corp. will raise its capital from $200,000 to $500,000 to permit of manufacturing on a large scale.

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DIVIDENDS DECLARED

Chandler Motor Car Co., extra of 1 per cent, payable July 1 to stock of record June 15.

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Pierce-Arrow Motor Car Co., initial of $1.25 on common, payable Aug. 1 to stock of record July 14.

—

DETROIT, May 21—The Continental Motors Corp. has declared a dividend of 1½ per cent on the company's common stock. The dividend is payable June 15 to stockholders of record on June 5.

—

AKRON, May 21—The B. F. Goodrich Co. paid a quarterly dividend of 1 per cent, on its common stock, last week, which amounted to $600,000. The Portage Rubber Co. disbursed $45,000 in payment of its quarterly dividend of 2½ per cent.

Automobile Securities Quotations on the New York and Detroit Exchanges

	Bid	Asked	Net Ch'ge
*Ajax Rubber Co.	67	70	—2
*J. I. Case T. M. Co. pfd.	84	86	+1
Chalmers Motor Co. com.	..	30	..
Chalmers Motor Co. pfd.	..	..	..
*Chandler Motor Car Co.	86	87	—4½
Chevrolet Motor Co.	95	99	—1
Fisher Body Corp. com.	34	38	..
Fisher Body Corp. pfd.	87	92	—2
Fisk Rubber Co. com.	70	75	..
Fisk Rubber Co. 1st pfd.	103	106	..
Fisk Rubber Co. 2d pfd.	92	95	..
Firestone Tire & Rubber Co. com.	124	127	—1
Firestone Tire & Rubber Co. pfd.	106	108	..
*General Motors Co. com.	102¼	102⅝	—3⅛
*General Motors Co. pfd.	87½	88	..
*B. F. Goodrich Co. com.	49¾	50½	+1
*B. F. Goodrich Co. pfd.	106¼	108⅛	..
Goodyear Tire & Rubber Co. com.	194	198	—3
Goodyear Tire & Rubber Co. pfd.	106	108	— ½
Grant Motor Car Corp.	3	6	—1
Hupp Motor Car Corp. com.	2¾	3¼	— ¼
Hupp Motor Car Corp. pfd.	74	80	..
International Motor Co. com.	..	10	..
International Motor Co. 1st pfd.	33	50	..
International Motor Co. 2nd pfd.	10	20	..
*Kelly-Springfield Tire Co. com.	51	53	+3
*Kelly-Springfield Tire Co. 1st pfd.	87	94	..
*Lee Rubber & Tire Corp.	18	18½	+ ¼
*Maxwell Motor Co., Inc., com.	48	48½	—2½
*Maxwell Motor Co., Inc., 1st pfd.	64	66	—1
*Maxwell Motor Co., Inc., 2nd pfd.	30⅜	31½	— ⅝
Miller Rubber Co. com.	185	195	—5
Miller Rubber Co. pfd.	104	106	— ½
Packard Motor Car Co. com.	..	151	..
Packard Motor Car Co. pfd.	..	99	..
Paige-Detroit Motor Car Co.	29	30	+2
Peerless Truck & Motor Corp.	13	15	+2
Portage Rubber Co. com.	136	143	—4
Portage Rubber Co. pfd.	..	..	..
Regal Motor Car Co. pfd.	..	24	..
Reo Motor Car Co.	27½	28½	+1½
*Saxon Motor Car Corp.	36	38	—7¼
Springfield Body Corp. com.	52	57	..
Springfield Body Corp. pfd.	110	117	..
*Stewart-Warner Speed. Corp.	72½	73½	—1¼
*Studebaker Corp. com.	80¼	80¾	—7½
*Studebaker Corp. pfd.	98	102	—5
Swinehart Tire & Rubber Co.	64	67	—1
United Motors Corp.	28⅞	29⅛	+ ¼
*U. S. Rubber Co. com.	56½	57	+2
*U. S. Rubber Co. pfd.	104	106	—1½
*White Motor Co.	44⅛	44½	— ⅝
*Willys-Overland Co. com.	26⅛	26⅜	—1⅜
*Willys-Overland Co. pfd.	93¼	94	..

*At close May 21, 1917. Listed New York Stock Exchange.

OFFICIAL QUOTATIONS OF THE DETROIT STOCK EXCHANGE

ACTIVE STOCKS

	Bid	Asked	Net Ch'ge
Auto Body Co.	..	29	..
Automobile Crankshaft Corp.	..	..	..
Bower Roller Bearing Co.	33¾	37¾	+ ¼
Chevrolet Motor Co.	..	..	..
Commerce Motor Car Co.	..	12½	..
Continental Motor Co. com.	7⅜	7⅞	+1⅛
Continental Motor Co. pfd.	..	..	..
Edmunds & Jones com.	..	..	..
Ford Motor Co. of Canada	220	240	..
Hall Lamp Co.	..	24	..
Hayes Mfg. Co.	..	..	..
Michigan Stamping Co. com.	14½	15½	+ ¼
Motor Products	40	..	+2
Packard Motor Car Co. com.	..	150	..
Packard Motor Car Co. pfd.	..	98½	..
Paige-Detroit Motor Car Co.	29¼	29¾	+2¼
Prudden Wheel Co.	22	26	..
Reo Motor Car Co.	27¼	27½	+ ¼

INACTIVE STOCKS

Atlas Drop Forge Co.	38	41	..
Kelsey Wheel Co.	..	40	..
Regal Motor Car Co.	..	26½	..

The Automobile

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Our Political Burden

THE automobile industry is going to profit by the re-writing of the war revenue tax scheme which is now practically agreed upon by political Washington. Since the educational campaign with the government on the automobile industry started political Washington has obtained more potential facts concerning the automobile industry and has corrected its highly erroneous ideas regarding the industry. The campaign waged by the automobile manufacturers has already accomplished much, and legislators will be more inclined to place the automobile industry in its correct perspective from this date forward. Washington has learned that, while a few manufacturers have grown rich in building automobiles, most of them have not and could not stand the 5 per cent tax. The speeches made in Congress have already done much to correct the perspective of the legislators on the automobile industry. It is well that this work has been done. It would have been done before had the occasion demanded it.

Unfortunately political Washington does not yet know that the motor truck is a business necessity. The legislators apparently look upon many motor trucks as expensive forms of advertising the owner's business rather than seeing in the truck a new and necessary business essential. The motor truck is becoming as essential in business as the telephone, the telegraph, the wireless, the typewriter, the dictagraph, and every other bit of apparatus that has in mind more efficient transportation. Washington has not realized this. Washington does not see the motor truck filling the same rôle of duty as the freight car, the river barge, the lake steamboat, the horse truck, the trolley, freight, or express car, etc. It is unfortunate. It will be deplorable should the 5 per cent tax be lodged against the automobile, but it will be trebly so should it be imposed upon the motor truck.

Lower M. E. P.?

EVERY consideration of the use of kerosene and slightly heavier oils in automotive engines points at present to one thing which will have to be sacrificed, and this is the high mean effective pressures attained so easily with gasoline. To-day a well-made automobile engine exceeds 100 lb. m.e.p. over about half its power range.

The use of a wet vapor of kerosene as we can use a vapor of gasoline is impossible; and it is still more impracticable to use heavier oils still in this way. If we make something like a fixed gas, which can be done, then it has to be kept so hot that the bulk of mixture which can be drawn in is reduced. If we adopt the injection type of engine and burn the fuel in an excess of air we can get a high m.e.p., but are limited as to the possible speed of revolution to something very much lower than present automobile practice.

Thus everything indicates that we must look forward to a decrease in power from engines of given size as we use heavier fuels.

Power per unit of piston displacement has been made somewhat of a fetish. There is really no direct gain by having an m.e.p. of 110 lb. as compared with 90 lb., except that the higher pressure engine can be a little smaller and therefore a little lighter. If we do have to return to volumetric efficiencies comparable with those of five or six years ago when an m.e.p. of 80 to 90 lb. was considered good, it merely means that we must increase bore or stroke or number of cylinders. Luckily we have learned in the meantime many ways for saving weight, and we could build to-day engines with a maximum m.e.p. of 90 lb. which would not be much heavier for their power than the higher pressure engines now regarded as the leading type.

It is probably time that automobile engineers gave up studying power per cubic inch in their engines and gave attention to power per pound of weight, which is vastly more important.

Aircraft Standards

THE article by W. F. Bradley on page 996, while it points out what the allied armies have lost by absence of aviation engine standards, shows very clearly that the greatest difficulty is the absence of such engine bed standards as have recently been adopted by the S. A. E. The ideal, which Bradley mentions, is to be able to take out one engine and put in another without structural alterations to the plane. This will be possible with the S. A. E. dimensions which allow plenty of latitude in detail design of the engine.

Farm Tractor Design—II

The Best Engine—Present and Future

This is the second of a series of articles dealing with the problems to be overcome in producing the vast quantity of tractors essential for increasing the world's food supply. The first article pointed out that a big market awaits a good tractor, that the engine is the principal unit, and that it is not possible to set a definite price limit.

By A. Ludlow Clayden

1—Tractor engine hardest worked of all.
2—Use of heavy fuel impairs reliability.
3—Many makers taking dangerous chances.
4—Ideal engine a long way off.
5—Possibilities of alcohol engines.

THE tractor's most important part is its engine and, while it is easy to make a tractor motor which will do well according to our present lights, whether present best performances will be regarded as good in ten years' time is very doubtful. The tractor engines now in use are developed either from the automobile engine or from the stationary type of slow-speed gas engine; but it is easy to overlook the fact that the service demanded of a tractor motor is many times harder than either of the above-mentioned power units has to suffer.

For severity of service combustion engines may be classified as follows in order, the first being the hardest, the last the easiest:

1. Aviation engines in planes or dirigibles.
2. Tractor engines.
3. Heavy-oil marine engines.
4. Light-oil marine engines.
5. Automobile engines.
6. Stationary gas and oil engines.

Thus the automobile motor is given the easiest existence of all but one of these six divisions. These degrees of hardness of work to be done do not altogether represent difficulty of manufacture in inverse ratio, because there are compensations. For instance, the light-oil marine engine can be made to withstand long hours at full power by an increase in weight, and the same is true to some extent of tractor motors. Still figure it how you will, the tractor engine remains the second hardest to build if we are seeking efficiency and continued durability.

Since nearly all running is done at full power on both aviation and tractor engines, the principal difference between them is that of weight per horsepower. In other terms, this means that the tractor engine can have a low mean effective pressure, while the aircraft engine must have a high one, and that durability can be sought by size in one case, whereas it can only be obtained from high-tensile material in the other.

At first sight, this looks as though the tractor engine was a far easier proposition, but there is another factor, perhaps the most important of all, which in a sense makes the tractor engine the hardest of all to build successfully. This is that of all the engines classified the tractor powerplant is likely to get the least attention, while it operates under absolutely the worst conditions. An aircraft motor gets constant skilled attention and may be designed for experts, the engineer knows that the mechanic will at least understand it and be able to keep it in tune. The aircraft engine does not work in clouds of dust, it is not bumped and shaken, it can be sure of ample clean oil. Lastly, but far from least, it gets *good, clean, light fuel.*

The Ideal Engine

The ideal tractor engine should operate forever, at full power, on low-grade heavy fuel, with no attention. Obviously an unobtainable ideal but one we shall always have to strive for.

Again to classify, the main problems of tractor engine design appear to be as follows:

1. Reliability without skilled attention.
2. Capacity to use heavy fuel.

The fulfillment of the first condition is rendered vastly harder by the presence of the second.

Heavy Fuel Difficulties

It is rather a sweeping statement, and will no doubt be challenged, but it is really true that the only entirely successful heavy-fuel engines in existence are those in which the cylinders are large enough to permit the fuel to be metered and injected. Further, none of these engines have been able to do well in any service without skilled handling, not necessarily highly skilled, but much more skilled than the tractor engine is going to get. By heavy fuel is meant anything as low in vaporizing quality as commercial kerosene. Actually when we have cut out everything that goes into the lower three-quarters of the distillation curve of present-day gasoline, it does not seem to make much difference for a good distance farther. In other words, it is much harder to change from gasoline to kerosene than from kerosene to fuel oil.

However, let us first take the things which make for mechanical reliability without complications. First comes low unit pressures, which means large bearings and large parts so that the stresses throughout are low. Here the limitation is the forces due to reciprocation and centrifu-

gal action. An engine is not made more reliable by being merely increased in size beyond a certain point, and we have yet to find just where that point occurs.

Workmanship Is Important

Next comes workmanship. Taking a bearing as an example, its life depends upon its unit loading to a great extent, but to an even greater upon its original fitting and its lubrication. No crankpin is perfectly round, there is always some error, but the nearer we get to perfection the better the condition for the bearing. So with cylinders and pistons, the smoother they are at the start the longer will they stay smooth. It is rather hard to get rid of the idea that the big engine with a very low power per cubic inch need not be made so accurately as the automobile motor, yet this is absolutely the wrong way to look at it. The better the finish on its wearing parts the longer will any machine run without trouble, so for shafts and bearings the tractor engine deserves *at least* as good workmanship as an aviation engine. There are not a dozen passenger car engines made to-day that would stand continued running at three-quarter power for an aggregate of several months, yet this is just about what the tractor engine gets.

Now, to consider the complicating effect of heavy fuel: the worst action it has upon reliability is the cutting of lubricating oil. This is not a trouble confined to heavy-oil engines, it occurs to a considerable extent with automobile motors; as soon as we have to deal with a vapor instead of a dry gas, action upon the oil will begin. With the tractor engine the case is worse because of the larger amount of fuel burned in a given time and because of the desire to reduce the light fractions in the fuel to a minimum.

Heavy Fuels Practicable

There seems to be an idea, somewhat prevalent just now, that engines modeled upon the stationary type are better able to handle heavy fuel than automobile engines. There is really nothing to support this, because the conditions are just the same for both. There is just one way in which a few stationary type engines have scored over the other, and this is that they are not always fitted with circulatory lubrication systems. Assume a lubrication scheme where each drop of oil is only used once, and is then thrown away; then the heavy fuel cannot do much damage to the mechanical reliability of the engine, but the oil consumption becomes a serious item or else all parts are starved of oil and their reliability impaired thereby.

It is a fundamental fact that a dry gas cannot be made from kerosene which will not become wet again on the slightest provocation, such as a trifling change in speed or load. Some inventors are approaching a metering system which will adjust the quantities of fuel, air heat, and perhaps water too, so delicately that all will respond automatically to speed and load changes.

This is the ideal apparatus for attaching to a four-stroke cycle engine designed to operate on *gas*, as are all engines with carbureters or vaporizers.

The other type of engine is that in which fuel is injected and burned in an excess of air. The best known is the Diesel; the most satisfactory in small sizes, the hot-bulb engine, commonly misnamed the semi-Diesel. Here the fundamental difficulty is that of proportioning the quantities of fuel injected to the speed and load, and no engine of this sort has yet been built commercially that would work on a tractor without moderately skilled handling.

Thus we have two things to work for in obtaining the heavy-fuel tractor motor: Either the perfect vaporizer which will deliver a gas that can be handled *as* a gas in the engine, or a super-Diesel or super-hot bulb which will not have the mechanical defects of this type, as at present made for stationary service in small sizes.

Just at present it appears that the probability is very strongly in favor of the perfection of the vaporizer preceding the perfection of the injection engine. The injection engine becomes harder to build with every decrease in the size of individual cylinders, and this is a serious handicap to tractor developments.

Again, to give an opinion that is not shared universally but is gaining ground, it is unthinkable that any engine with less than four cylinders can have a lasting place in tractor propulsion. If we are to have four cylinders they will need to be fairly small, much smaller than any which have been handled successfully as yet on the hot-bulb or Diesel principles.

Let it not be forgotten that the market for small stationary engines to run at constant speed and almost constant load, on heavy fuels, is much larger than the supply. The perfect engine of the hot-bulb type would be bought just as eagerly for stationary work as for any other, but the world is still waiting.

The Kerosene Illusion

Among the tractor producers a number claim to use kerosene, but one notices their demonstration machines operate mostly on gasoline. Particularly among the users of two-cylinder opposed engines one sees kerosene burning attachments that cannot possibly work without flooding the cylinders with raw fuel. Crude is altogether too mild a word to describe them. Once warmed up, a conventional passenger car will run on kerosene without carbureter alteration, *after a fashion*, and it is in about the same fashion that a big percentage of the nominally kerosene-burning tractors run. In a number of the layouts almost every known law for kerosene vaporizing is disregarded. Something that can just be "got by with" is not going to encourage the farmer to place a repeat order. It is better policy at the present to insist on the use of gasoline or gasoline and kerosene mixed than to pretend to do things on raw kerosene that cannot really be done.

A well-known engineer once said that one of the difficulties in tractor-engine making was that there "wasn't an eighth of an inch of coast in a tractor," meaning that if the engine missed a few explosions it stopped instantly. Similarly there isn't a long period of life for the tractor maker who depends upon exaggeration to sell his goods. You can fool a man a lot about the results he gets from his automobile, a little about what he gets from a truck, but there is no fooling the farmer *after* he has put his tractor to work.

Alcohol a Possibility

There is another possibility, the alcohol tractor. The opinions of experts as to the practicability of alcohol production on a large scale are diverse, but there is a fairly general agreement on the broad idea that alcohol can be produced from waste vegetable matter, and that if we can find the way to get enough raw material at one spot to keep a big still running we can have cheap commercial fuel. Alcohol, if it does come into use widely, will probably do so slowly. In certain parts of the world, notably the tropics, it can be made more cheaply than elsewhere and in such places we shall see the growth of demand for alcohol-burning engines for all purposes. Alcohol carburates fairly easily, is a good, clean fuel, in fact, but it is of only half the thermal value of mineral oil. To burn it efficiently we need high compression, far higher than any gasoline engine, and even then to get the same power we have to burn approximately double the quantity. France has for many years tried to encourage the

use of alcohol and trials held by the French government showed that the burning of alcohol in engines of the conventional automobile type, but of higher compression, was perfectly easy.

A thought suggests itself here which is that it should be worth the while of some tractor-engine builders to ascertain the best compression and to discover any other special fittings required for alcohol usage. There is reason to believe that any engine, almost, with detachable cylinder heads, could be constructed so that all the change necessary for alcohol burning would be a new head, just as a new head with lower compression is to be supplied for Ford cars which are converted to burn kerosene.

Still, the whole question of industrial alcohol is in the hands of political economists; it is quite out of the province of the engineer, and it appears certain that heavy oil will be a cheaper and better fuel to use for a long time to come, if we can only discover how to overcome its inherent defects.

Fuel Problem Will Be Solved

There is no reason for despair on this fuel question. It took a great concentration of effort to produce the gasoline motor and develop it to the present state of comparative efficiency. Nothing like the same amount of effort has been put into any other type of combustion engine, even the large gas engine has not had so much work done on it.

Look back fifteen years. In the automobile field then there were about a dozen makers of automobile engines which would drive a car 10,000 miles without a thorough overhaul; all the other engines were more or less constantly troublesome. And the dozen good engines were nothing by comparison with what we have to-day.

The automobile industry has now been at work on the heavy-fuel engine for about a year, seriously that is, and it is reasonable to expect another five or more to elapse before much is accomplished.

Perhaps it may be thought that what the automobile industry does or does not do is of smaller importance than the work of the older gas-engine men, but this is not so. The automobile industry knows more about small combustion engines than the gas-engine builders know about large units. It has built many times as many engines, it is much more closely appreciative of the operating conditions for engines on any kind of vehicle, it has fewer fixed ideas, it carries out experimental work more rapidly than any other industry in the world. Most important of all, perhaps, its new ideas are tried out by the tens of thousands instead of by the tens without the thousands. It has a prodigious army of users testing things for it and rendering the results of their tests speedily.

To go back a little it may be explained why the four-cylinder engine seems better than any with a lesser number. A two-cylinder engine can be almost as well balanced but it cannot have the same even flow of power, the torque variations must be much greater. For the same power the pistons must be larger, and, as the impulsive pressures will be larger the individual parts must be stronger and heavier. It is argued that there will be more two-cylinder tractors built this year than ever before, but the fact that Ford's output is so huge does not mean that all the features of the Ford car are examples of the best engineering. Output from one factory is no index whatever of engineering quality. Some of the most efficient and in every way best automobiles are made by small firms. In the tractor field just now it is the small firms which are evolving the ideas, the large ones that are copying at a later date; at least, this is true to a great extent. It is true still in the automobile industry, it is true in other industries. The best possible thing for the development of any machine is to have a large number of competitive firms engaged in its production.

Descending to the simplest illustration for support of the contention that four is a minimum number of cylinders for a tractor, let anyone who doubts it ride on a half dozen different tractors, some with two and some with four cylinders. Then let him say on which he thinks nuts will shake loose quickest, on which he thinks the gears will last longest. There is only one opinion.

A Need for Small Tractors

Just a small reservation. There is going to be a need for small tractors with first cost as the prime consideration, as stated in the last article of this series. In small sizes the two-cylinder can be built cheaper and it may have a permanent place on this account. The smaller the machine the less the disadvantage of a two-cylinder engine; the cheaper a machine the more drawbacks must we be prepared to endure.

A cheap machine can never be as efficient as a machine made as well as possible commercially. This does not mean that the most expensive is necessarily the best, but merely that to make any machine honestly costs just so much; if we go below this figure something must be sacrificed.

Efficiency is a much misused word, but there is only one meaning for it in tractor estimation. *The most efficient tractor is the one which will do the most work for the least money for the longest time, and with the fewest breakdowns.* It does not take long for a tractor to burn up $100 worth of fuel, even with an engine of high fuel efficiency, so $100 more or less on the first cost of a medium-size machine is of little account. What mischief can be done by trying to save this on first cost may be exemplified by an actual experience.

A certain stock engine appearing on paper to be most excellently designed for tractor work was tried out experimentally by a tractor maker building his own motor. It was considerably cheaper than the latter engine but the design looked good. On the block the stock motor showed up well, in service it did well for a time. Then one thing after another happened. A connecting-rod broke, owing to defective material, the camshaft bearings gave out, apparently due to an original disalignment of the center bearing with the other two; after taking down the oil pan there was trouble in getting a tight joint on reassembling because the finish of the faces was rough and too much reliance was placed upon a soft-cork gasket. There were other troubles, all due to poor material or to rough workmanship.

Tractor Engines Best Built

To-day the tractor engines which are giving the best service are the best-built engines and the best-built engines are mostly being made along the lines of the best truck motors, only a little heavier: About halfway between the engines of a truck and a cruising type power boat for weight, and nearer the former for speed. The speed tendency is upward, because with higher speed comes more even torque and smoother operation. Just as the truck engine developed from that of the passenger car and shouldered out other forms of heavy-duty engine, so does the tractor engine appear to be developing from the truck motor.

Is this going to be a lasting thing? It will be lasting as long as we use for tractors engines burning *gas* or such forms of vapor as act reasonably like a gas. If there is a change it will come in the form of something new and will affect tractor, truck, boat and even passenger car, possibly aircraft as well.

Must Minimize Army Truck Weight

Tractive Factor Coefficient in U. S. Government Requirements Means Weight-Displacement Compromise

By C. T. Myers and J. E. Schipper

PARAGRAPH 30 of the United States Army specifications for war department trucks states that the Government trucks must have a definite tractive effort factor. The paragraph says that the tractive factor obtained by dividing the net tractive effort at the tire surface of the driving wheels by the total weight of the fully loaded truck shall be not less than 0.0775 on high gear and not less than 0.338 on low gear. This tractive effort shall be based on 85 per cent efficiency of power transmitted from engine to driving wheels on high gear, and on 70 per cent efficiency on power transmitted from engine to driving wheels on low gear.

The fact that the Government has specified the tractive factor shows the realization of the fact that a mathematically accurate selection of the proper truck characteristics has to be made. The Government, acting as the purchaser, has realized that a scientific analysis of the qualifications of the trucks is absolutely necessary if the best performance is to be secured. This brings the question directly back to the truck manufacturer and opens the question of what compromises must be made between possible varying factors in the tractive effort formula. This formula is the same as that which has been presented to the Society of Automotive Engineers in the past and may be found in the Transactions under contributions by Cornelius T. Myers for January, 1913, June, 1914 and June, 1915. An article on this also appeared by the same author in *The Commercial Vehicle* for July 15, 1915, and these four publications give a complete history of the derivation and development of the formula. The formula itself reads as follows:

$$T F = \frac{8.4\, n\, b^2\, s\, R}{D\, W} \times E_m \times E_t$$

$T F$ = Tractive factor = pounds push at the driving tires per pound total weight of truck and load.

n = Number of cylinders, b = bore of motor, s = stroke of motor, R = gear reduction, D = diameter of driving tires, W = total weight in pounds.

E_m = motor torque efficiency with reference to ALAM equivalent. E_t = efficiency of complete transmission system.

$T F$ might be called the Truck Coefficient because it is an indication of the ability of the truck to get over various kinds of roads and up grades.

The two great variables which must be made to properly correlate are the engine size and the total weight moved. This will be a matter of give-and-take, the minimum truck weight being fixed by the proper amount of sturdiness and by the requirements of other parts of the specification list and the minimum of horsepower or displacement, depending upon the other factors in the above formula, as well as upon the requirements given by the specifications.

Strength Is Essential

It is quite evident that within certain narrow limits there will be a motor size best suited to the conditions as laid down by army service, and the solution for the problem opens some interesting questions on the amount of dead weight that it is possible to cut off the truck design and still have sufficiently rigid construction. Naturally, the lightest possible truck which is sufficiently strong for the service is the logical answer to the question. In the truck specifications some of the factors in the formula are fixed.

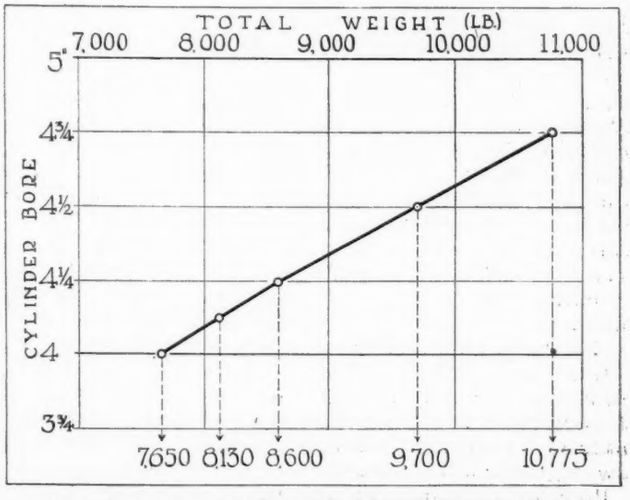
Taking the factors one by one and discussing them, it will be noted that regarding n, the number of cylinders, the requirements are that there shall be not less than four cylinders, and as it is extremely unlikely that there will be more, the factor n may be considered fixed at four; b, the bore, remains one of the open questions; s, the stroke, must be varied in relation to the bore so that the piston displacement will be above the required 312 cu. in. as laid down in the paragraph governing the engine; r, the gear reduction, is one of the points which have been left open within certain limits and thus it becomes one of the variables which allow a certain amount of latitude to designers; D the diameter of the tires, is fixed by the specifications. The remaining factor, W, is the other quantity with which manufacturers will have to juggle.

Examining the three variable points remaining in the formula, it will be noted that the question resolves itself down to a discussion of the relation of b^2 and W; that is the square of the bore and the weight, with the gear reduction a factor which acts as a connecting link between the two.

Gear-Reduction Factor

The question of road resistance is of course taken as much worse than would be likely in commercial service, and hence the low gear reductions have naturally been brought to a much lower level than would be required were the truck to be used for work which could be estimated quite closely. At the same time, while acting to a seeming disadvantage in one respect, this low gear ratio will result in a very high propulsion torque at low speeds. The accompanying curve illustrates the manner in which the variations, depending on different combinations of b^2 and W, lead to different results which all fall within the scope of the required tractive factor.

The accompanying curve shows what may be expected in the way of the relation of engine size to total weight. It clearly illustrates that a 4¾ in. bore is necessary to drive a truck of the maximum weight allowed by the War Department specifications. It will be necessary to reduce the weight in order to use a smaller displacement factor. For instance, a 4¼ in. bore on this basis would give the same tractive factor with 8600 lb. total weight as a 4¾ in. bore with the maximum 10,775 lb., whereas the total weight that can be handled by an engine of 4-in. bore is only 7650 lb. A slight complication arises when it is remembered that increase in engine size necessarily means some increase in weight.



Taking 4¾ in. bore of cylinders to drive an army truck of the maximum weight allowed by the U. S. government specifications, the curve shows how weight must be reduced to use smaller cylinders

Airplane Standards Needed

37 Types of Aviation Engines in England and Nearly 50 in France Result of Failure To Standardize Early in War—Germany Has Only 5 Types—Lessons for U. S.

By W. F. Bradley

DESPITE an airplane development which has assumed fantastic proportions, comparatively little attention has been paid by allied engineers to the question of standardization. The general plan appears to have been to secure the greatest output without stifling initiative, or indeed to encourage initiative even if it is somewhat to the detriment of output. The plan is open to criticism, and its weakness is apparent when it is stated that there are in England thirty-seven different types of aviation engines and not far short of fifty in France.

In view of the state of aviation development in Europe at the outbreak of war, it is doubtful if any other plan would have been more successful, and it is certain that the German system of complete standardization and absolute uniformity would not have satisfied French or British temperament. Under the German system there have been developed five aviation engines, two Mercedes, two Benz, and a German Gnome, which is a copy of the French engine as it existed at the outbreak of war. Everybody is building one or other of these types, the result, of course, being an all-round simplification both in the factories and in actual service.

Now that progress has been made, that competition has brought forth planes and engines infinitely superior to anything possessed a couple of years ago, the disadvantages of varied types are making themselves felt. It is only now that the question of uniformity and standardization is being really seriously considered. There are declared to be plans in hand which will put an end to the lack of system existing up to the present and thus render possible an immense increase in output.

Undoubtedly much remains to be done, for the only interchangeable parts in airplanes or airplane engines at the present time are propellers and magnetos.

In France the type of magneto adopted is the S.E.V., being a development of the Bosch as it existed prior to the war, the base and coupling of which have been made uniform throughout the service. Thus any magneto on any engine will interchange with any other.

Propeller mountings are also standardized, there being two dimensions, according to whether the horsepower is below or above 100 hp. The difference between the two only relates to the length of the shaft.

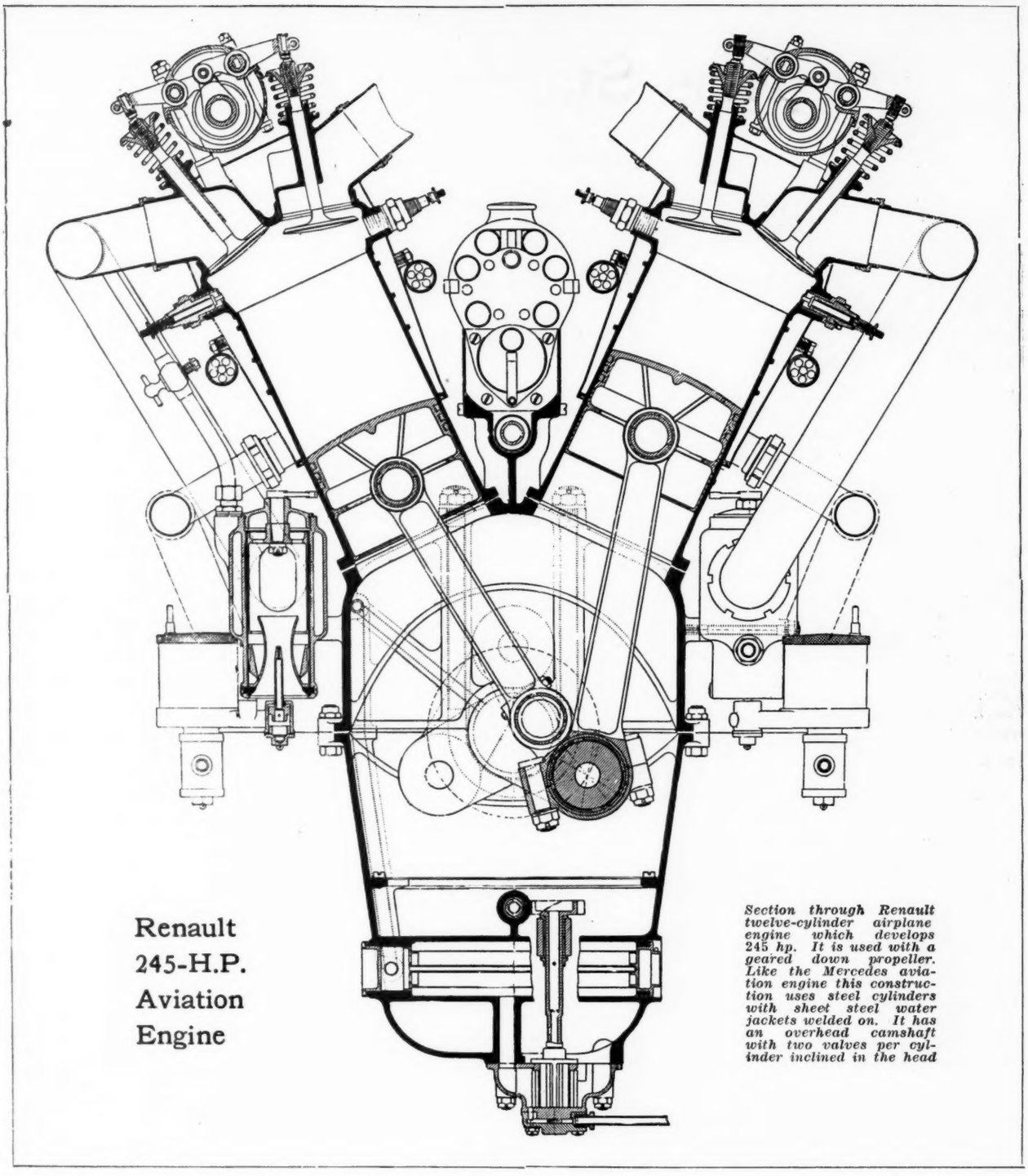
Engine mountings are not standardized, so that every plane has to be built for one type of engine and will not receive any other. Now that there are in existence quite a number of engines differing only in structural details, the disadvantage of being unable to change from one make to another without modifications in the structure of the airplane is felt quite seriously. It is certain that this is one of the features in which standardization will be sought most promptly.

¶ EDITOR'S NOTE—This article is especially timely, now that the United States is marshalling its airplane designing and manufacturing resources for the needs of its army and navy in the great war. Mr. Bradley, special representative of THE AUTOMOBILE *with the allied armies, is one of the closest students of aviation development in Europe and is, moreover, qualified to speak on standardization of its details through a comprehensive knowledge of American methods in the automobile industry.*

Except that everything is to metric system, there is no standardization of screw threads, nuts and bolts, cotter pins or washers, turnbuckles or sizes of wires. Every maker has been allowed to adopt his own sizes without any consideration of what was being done by his neighbors, and without any effort toward uniformity. The same remark applies to wing planes, spars, distances between plane supports, etc. In view of the great simplicity of airplane construction—as distinct from airplane engines—which makes it possible for coachbuilders, carpenters, and others of no previous experience in airplane work to produce successfully to given designs within a very short time, it is surprising that there has not been an earlier attempt at uniformity of parts.

While there is little general system, the war has brought about a co-operation among factories which would not have been dreamed possible less than 3 years ago. The construction of a really successful engine is not confined to the firm responsible for the design. Some successful engines are being produced in as many as twenty different factories, with twice this number of subcontractors making various parts for these firms. There are many licensees producing more engines per month than the parent firm produced in a year before the war.

From the standpoint of after-the-war production this is of extreme importance. Watertight compartments between factory and factory have been broken down. A once fourth-rate firm gets the advantage of the experience of the finest engineering shops; firms which not long ago knew next to nothing about the heat-treatment of metals know everything now; shops which before the war handled B.N.D. and other high-grade steels by the pound are now handling them by the ton; limits of tolerance which were considered impossible in many factories before the war have become everyday practice.



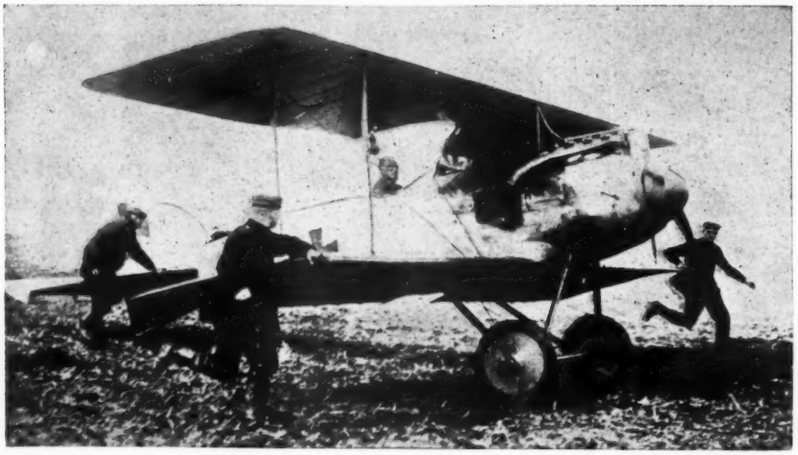
Renault 245-H.P. Aviation Engine

Section through Renault twelve-cylinder airplane engine which develops 245 hp. It is used with a geared down propeller. Like the Mercedes aviation engine this construction uses steel cylinders with sheet steel water jackets welded on. It has an overhead camshaft with two valves per cylinder inclined in the head

Work is being carried out in big series, it being not at all uncommon for a licensee to accept a single contract for one series of 2000 or 3000 engines. Speeding-up is shown by the fact that one firm producing an eight-cylinder V-type water-cooled engine is turning them out at the rate of six per day with a staff of only 700 workpeople.

Great Increase in Power

Undoubtedly the outstanding feature of the European development has been the great increase in the power of individual units. These are invariably of the fixed-cylinder, water-cooled type, with either eight or twelve cylinders. One of the best-known of these is the Renault twelve-cylinder 245 hp. engine with geared-down propeller. Contrary to general plan, the French authorities have allowed a drawing of this engine to be published in a book by Lieutenant De Montgrand. From this drawing, which is reproduced herewith, it will be seen that there is a general similarity with the Mercedes aviation type: steel cylinders with welded-on, sheet-steel waterjackets, overhead camshaft with valves inclined in the head, two valves per cylinder, and vertical drive for the camshaft.



Photograph by Underwood & Underwood

Prince Friedrich Karl of Prussia starting on his last flight in an airplane of his own construction. The Prince was made prisoner while flying over the British lines and died of his wounds. He is the first Hohenzollern to be killed flying an airplane

Another high-powered unit is the Sunbeam twelve-cylinder, overhead-valve, 330-hp. engine. There are in addition quite a number of engines varying from 350 to 400 hp. The biggest single powerplant appears to be a twelve-cylinder, water-cooled motor which actually developed 630 hp. on the bench tests. Also, more than one of these engines is carried in a single airplane. While a lot of work has been done in this direction, there does not appear to be a very strong tendency toward multiple powerplants, the more general tendency being toward a single unit with an engine running as high as 400 hp. The handling of any twin engine plane after one of the engines has stopped is a delicate task for the pilot.

125 M.p.h. Maximum Speed

It has been stated in the aeronautical press that European scout machines are now showing a horizontal speed of 150 m.p.h. It is very doubtful if there is any machine anywhere in Europe capable of this high speed. A horizontal speed of 200 kilometers an hour, practically 125 miles, is possible with quite a number of different makes; but it is found a very difficult matter to increase on this figure. This speed of 200 kilometers is obtained with engines of 130 to 150 hp. Thus, more than one make of plane shows a horizontal speed of better than 125 m.p.h. with the 150-hp. eight-cylinder Hispano-Suiza.

Equally important with the horizontal speed is the climbing speed and the altitude at which the horizontal speed begins to decrease. The French have termed this the "plafond," literally the ceiling, the highest point any machine can attain. Very much of an erroneous nature has been written on this point, and altitudes have been quoted which never have been attained by any heavier-than-air machine. As a matter of comparison, figures are given in the accompanying table for six European planes which, for obvious reasons, are nameless.

In considering speed at any altitude, a distinction has to be made between plane efficiency and engine efficiency. The two are often confused. It is quite possible for a plane to refuse to climb above a given height because of the diminution of engine power; with another engine, or with the same more correctly adjusted to that altitude, the plane would continue to climb. On the other hand, the inefficient design of the planes may prevent the machine climbing, although the power is available.

This question of the decrease of engine power with the increase of altitude has been thoroughly investigated by European aviation engineers, engine bench tests having been carried out on high mountains with the object of securing more accurate data than are available when the machine is in the air. Some of these tests show that after the engine had been adjusted to give the best results at sea level there was a loss of 20 per cent in efficiency when operating at an altitude of 6500 ft. Also it was found possible to regain the whole of this loss by increased compression, greater ignition advance and proper carbureter adjustment.

Engine Speeds Higher

With the increased size of power plants, the tendency is toward higher engine speeds and geared-down propellers. Thus, an engine running at 2500 r.p.m. and propeller at half this speed, develops 245 hp. The same engine with direct-mounted propeller develops 158 hp. at 1400, the highest number of revolutions permissible for propeller efficiency. The weights per horsepower are respectively 2.08 and 2.2 lb. These are not theoretical figures, but are those of engines actually in service. Considering an engine of the same design as the above, but of smaller dimensions, to produce 102 hp., the total weight with geared-down propeller is 412 lb., or 4.04 lb. per horsepower; the same motor with direct-mounted propeller is only 71 lb. lighter, but as the horsepower is only 62 at 1500 revolutions, the weight-horsepower ratio works out disadvantageously at 5.5 to 1.

No small amount of trouble has been experienced in the gearing down of high-speed engines, and one case could be mentioned of a very successful engine with direct-mounted propeller which develops crankshaft trouble when running at a higher speed with the screw geared down 2 to 1. In another case months were passed in experimenting and a considerable amount of money expended in endeavoring to find a cause for the failure of reducing gears to stand up to their work on a high-speed aviation engine. The defect was ultimately traced not to the gears but to the crankshaft, which was too light, there being vibration which was transmitted to the gears to their detriment.

There are two general types of construction, steel cylinders with welded-on sheet-steel waterjackets, the jacket generally being common to a pair of cylinders, and the aluminum cylinder with a liner. The latter enjoys the greater favor at the present time and seems likely to outstrip the former. In both cases overhead valves are used, with an overhead camshaft driven either by a train of spur gears, or more commonly by a vertical shaft and bevels. Even with aluminum cylinders the

TABLE OF COMPARATIVE SPEEDS OF SIX EUROPEAN AIRPLANES

Machine	Hp.	Climbs 10,000 Ft. in	Horizontal Speed in M.P.H. at			Maximum Height, Ft.
			6500 Ft.	10,000 Ft.	13,000 Ft.	
1	245	15′40″	105	102	..	19,000
2	245	30′15″	90	88	..	14,700
3	245	34′	79	77	..	14,700
4	150	9′50″	125	120	116	20,000
5	130	20′50″	96	90	86	18,000
6	300	21′30″	96	92	88	17,000

In cases 1, 2, and 3 the horizontal speed at 13,000 ft. is not given, although the machines can attain this altitude, as shown by their maximum height.

detachable head is avoided. The tendency is decidedly toward the use of four valves per cylinder, with a single camshaft for the sixteen valves of each group; in the engines developed from the Peugeot racing cars, however, there are two camshafts per group where only one existed on the car engines. The L-type twelve and eight have given way entirely before the overhead valve engine.

Y-Engine for Over 300 Hp.

Where powers of 300 hp. and upward are required, there is very much to be said in favor of the Y-engine in place of twelve cylinders in V. The overall length is decreased to that of an eight of equal bore and stroke, while the height is not very much greater than that of the more conventional type twelve, for this latter generally has a very deep crankcase, forming an oil reservoir, while the Y-engine carries no oil in the crankchamber. Engines of this type have been built with satisfactory results, the crankshaft being carried in ball bearings and all the oil maintained in a separate tank apart from the engine. The Sunbeam company has taken out patents for an eighteen-cylinder engine with six vertical cylinders and two groups of six inclined in relation to the central group.

While there have been fewer developments in the rotary type air-cooled engine, it has not by any means disappeared, nor is it likely to do so. Its use, however, is confined to powers not exceeding 130 or 140 hp. For the fast scout machines not required to keep aloft for more than 2 or 3 hr. at any one time, it has an advantage over any water-cooled engine within the powers mentioned. Another advantage, too, is its ability to operate in any position, and, as the single-seater scout machines are designed to perform all kinds of acrobatics, to loop-the-loop at the will of the pilot, and to perform long, vertical corkscrew dives, it is practically supreme for this class of machine.

Starting Magneto Used

Electric starting is not often adopted on European airplane engines owing to the excessive weight of the storage batteries necessary to spin an engine of large size. The general practice is to fit a starting magneto, and while this entails hand cranking it simplifies the task sufficiently to make starting possible in the air in cases where it would be impossible without this device. It is becoming more common to fit engine-driven electric generators for lighting purposes, these taking the place of the wind-driven generators employed some time ago. Power-driven pumps are necessary to maintain pressure on the gasoline supply to the carbureter.

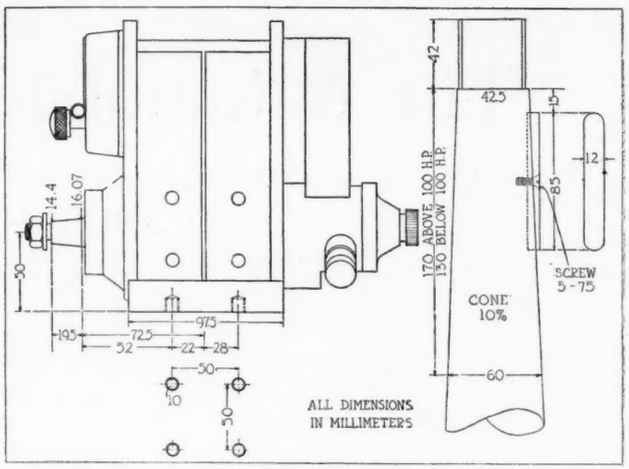
The efficiency of an airplane engine can be studied by the formula:

$$\frac{\text{Hp. per cu. in. piston displacement}}{\text{Weight per hp.}} = \text{Efficiency.}$$

According to this formula, an efficiency of 0.175 has been obtained with one of the latest and best engines produced in Europe. The data concerning this engine are as follows:

	Cu. In.
Piston displacement	1156
Hp.	390
Weight per hp	1.92
Hp. per cu. in. piston disp	0.337
Efficiency	0.175

This is a twelve-cylinder engine developing its full power at 2500 r.p.m. with a propeller running at half engine speed. A smaller engine, also with geared-down propeller, gives the following:



Left—S. E. V. magneto adopted by France for aviation. It is of Bosch type, and the base and coupling are standardized so that they are interchangeable. At the right is the standard propeller mounting

	Cu. In.
Piston displacement	763
Hp.	245
Weight per hp	2.15
Hp. per cu. in. piston dis	0.321
Efficiency	0.149

A third and very successful aluminum eight-cylinder engine, with direct-mounted propeller, gives the following:

	Cu. In.
Piston displacement	707
Hp.	150
Weight per hp	2.42
Hp. per cu. in. piston dis	0.233
Efficiency	0.096

In arriving at these figures weight has been considered with engine complete, but without water, fuel or oil.

—

Fatalities Lightest in Aviation Corps

WASHINGTON, D. C., May 21—Contrary to the popular opinion the air service of the army, although perhaps the most thrilling branch, is not the most dangerous. Captain Aubrey Lippincott, in charge of the personnel of the signal corps of the army, says that the records of our allies put air service fourth in the percentage of losses. The heaviest losses have been in the medical corps, next in infantry and third in artillery.

Although applications have been very numerous for enrollment in the six cadet schools for fliers recently opened, Captain Lippincott says many more men will be needed before the end of the year. One hundred and fifty men begin training to-day and one hundred and fifty more will begin each succeeding Monday. Enough men have been accepted to keep the schools supplied with recruits for more than 2 months, but several thousand will be required later on as the supply of men must be constantly augmented.

Only a small percentage of the men who apply for enrollment in cadet aviation schools at the universities of California, Texas, Illinois and Ohio, Massachusetts Institute of Technology and Cornell can be accepted. The requirements are stricter than in any other branch of the service. The impression that only college graduates are admitted is incorrect, but a substantial foundation for intensive technical training is necessary. It has often been found that three years at college or its equivalent gives a man the knowledge which makes the training come with reasonable rapidity.

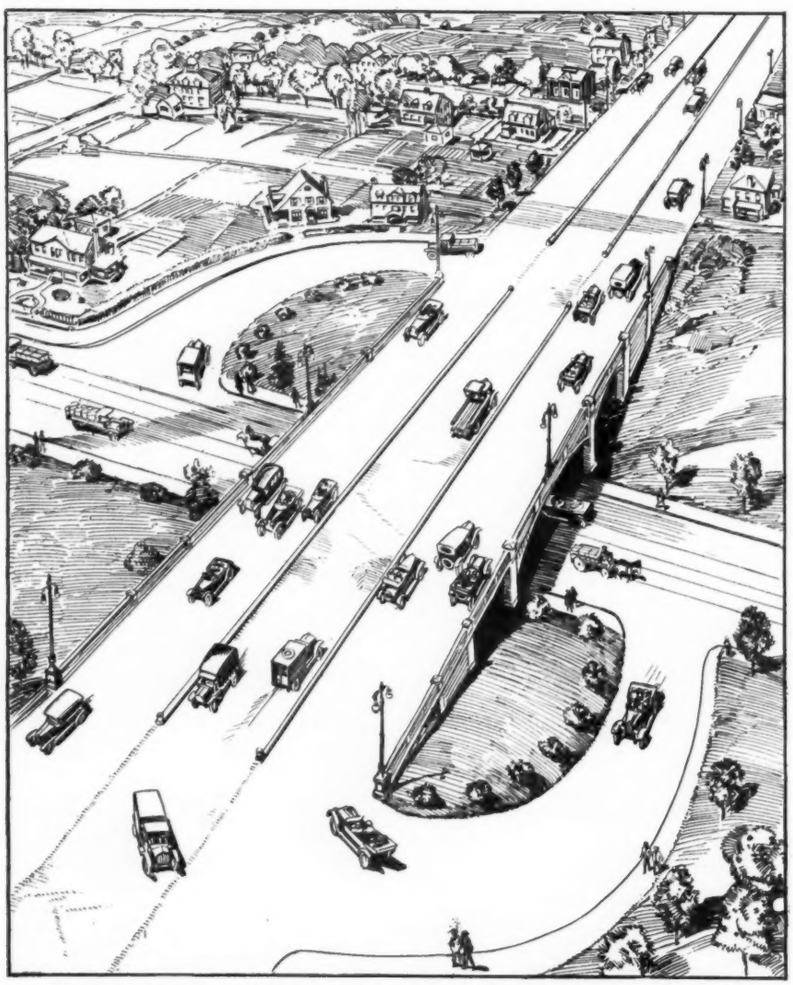
Not only are the educational standards high but the medical test for aviators is extremely severe. The examination lays particular stress on eyes, ears, heart, lungs, sense of touch and sense of equilibrium.

The Automobile's Road Revised

Suggestions by Prominent Highway Engineers Form Basis of Greatly Improved Design—Practical Value of Proposed Road Wins Wide Appreciation

IMPROVEMENTS suggested by prominent highway engineers form the basis of the revised details of design reproduced herewith for the modern motor highway proposed by THE AUTOMOBILE in its issue for April 5. The original form of this thoroughfare appears on this page, and the improved features are illustrated on the two following pages. It will be remembered that the publication of the suggested highway in connection with the announcement of the appointment of General Goethals as chief engineer of the State of New Jersey met with nation-wide approval and caused much favorable comment as a great step forward in the science of road-building in this country. The public at large, and road engineers in particular, recognized immediately the value of construction of the type proposed, especially in preparation for the hitherto unapproached increase in motor traffic which is bound to accompany development of the automobile industry and the general economic progress of the country in the future.

Many letters were received from men who have done much in the science of road building. These were published from week to week in THE AUTOMOBILE. To appreciate their suggestions, it is essential to understand the road as originally designed. Higher speed for motor vehicle traffic and greater safety resulting from segregation of this traffic, the elimination of grade crossing and one-way travel of high-speed vehicles were among the primary objects. The road as suggested would be a great highway linking New York and Philadelphia. It would be approximately 100 ft. wide with three parallel roadways, the two on the outside being intended for automobiles and the one in the center for motor trucks. There would be capacity on each of the automobile tracks for three or four cars abreast, with space in the center for three trucks abreast. Traffic would be in one direction on each of the outer roadways, but the trucks in the center roadway would travel in both directions.



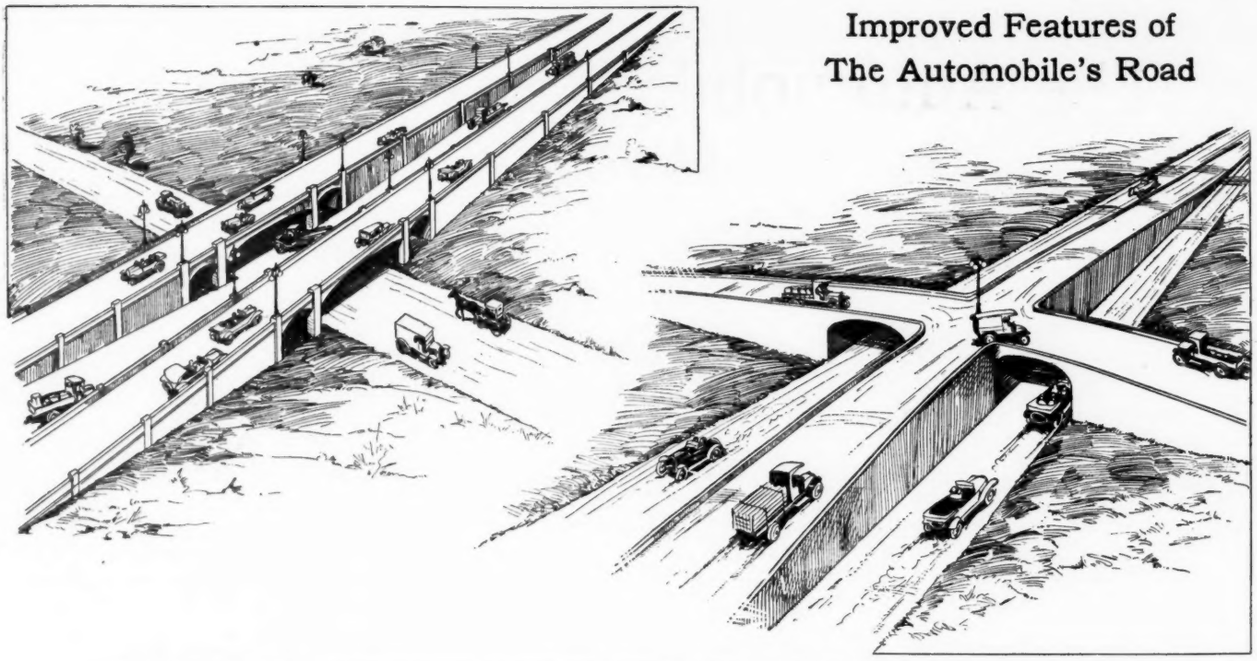
Original design of through traffic motor highway suggested in THE AUTOMOBILE for April 5 as a possible connecting link between New York and Philadelphia. It would propose to have this highway about 100 ft. wide and composed of three parallel roadways, the two on the outside being for passenger cars and the one in the center for commercial vehicles. Note the improvements outlined in the other illustrations.

E. P. Goodrich, consulting engineer, suggested in a letter published in THE AUTOMOBILE for April 19 that the plan of layout for high-speed vehicles on the outside tracks with slow-moving vehicles in the center would tend to cause congestion at each turnout. If the fast-moving vehicles were in the center they could shift over into the line of slow-moving vehicles at occasional points without slackening the average speed of those in the high-velocity zone. The road, as revised to meet the very excellent criticism brought out by Mr. Goodrich, is illustrated at the bottom of page 1001.

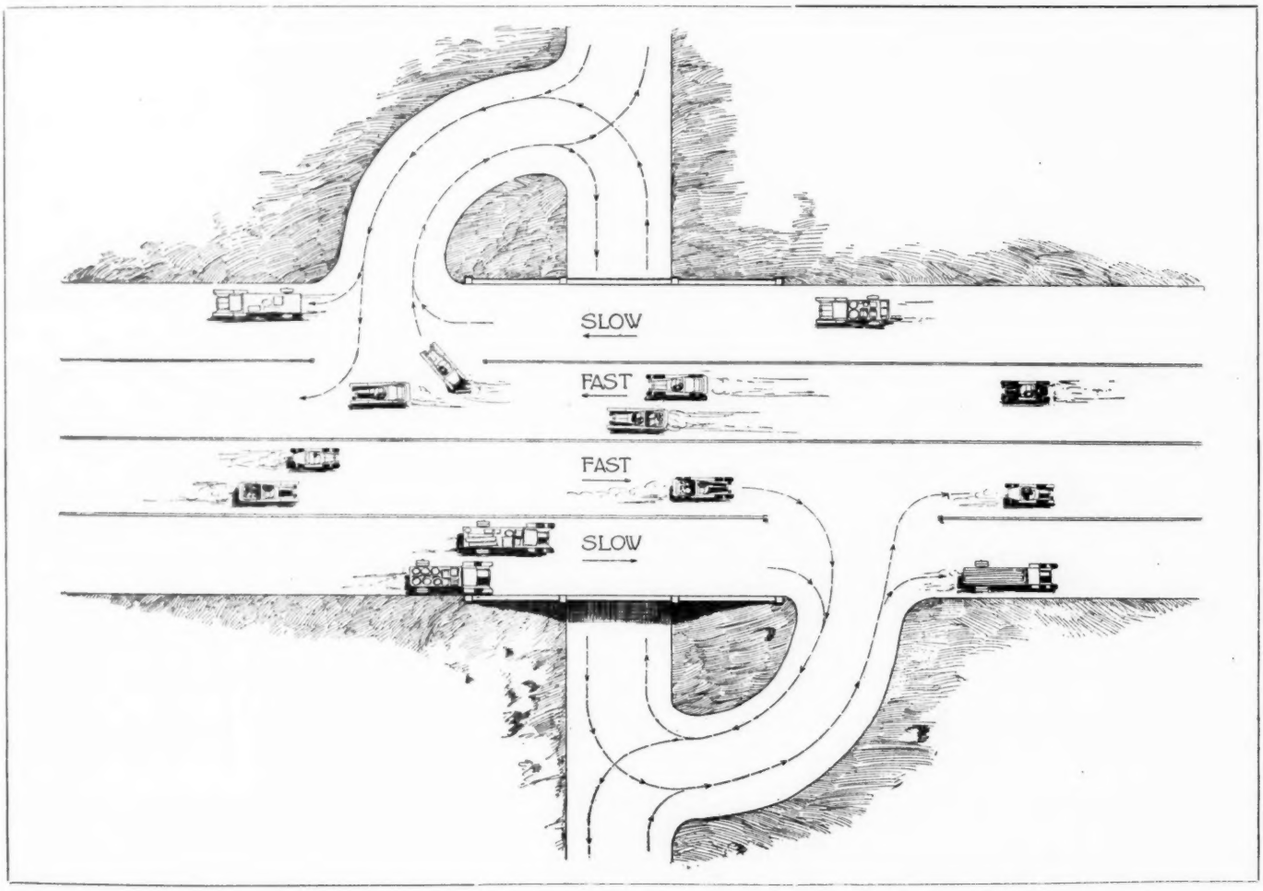
Harvey Linton, road engineer, in a letter published in the same issue of THE AUTOMOBILE, pointed out that for an underground crossing the grade of the center roadway could be depressed on the maximum allowable grade so as to come to the level of the crossing. Mr. Linton also suggested that the same principle could be applied to an overhead crossing. Sketches embodying both modifications designed in accordance with this principle appear at the top of page 1001. Another improvement proposed by Mr. Linton was that in mountainous country most economical construction of the three roadways could be carried out on hillsides by building them on three separate elevations according to the contour of the ground, with the necessary right of way. An illustration showing how this method of construction could be developed appears at the right on page 1002.

Coleman du Pont voiced a pertinent criticism in a letter published in THE AUTOMOBILE for April 26, stating that the method of approach to the highway outlined in the original design was not the most satisfactory that could be devised. This criticism was responsible for the revision of the approach as illustrated in the sketch at the bottom of

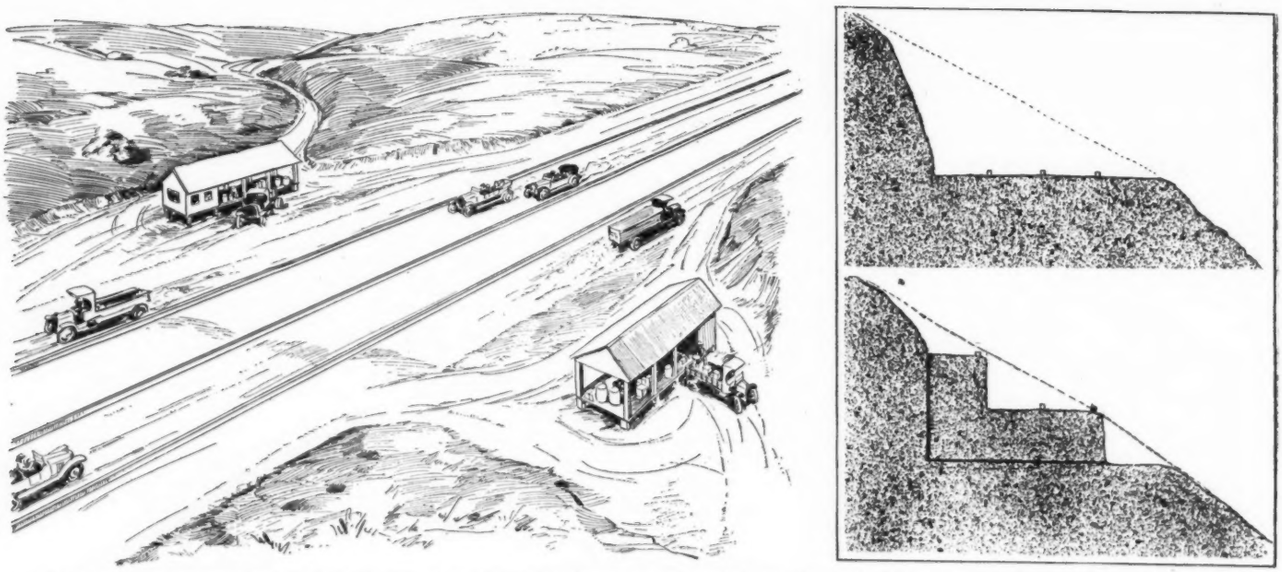
Improved Features of The Automobile's Road



Method of providing for underground or overhead crossings suggested by Harvey Linton, road engineer. The grade of the center roadway is depressed on the maximum allowable grade so as to come to the level of the underground crossing, and the same principle is reversed for overhead crossings



By placing the slow-moving vehicles on the outer tracks with the high speed traffic in the center the probability of slackening the average speed of cars in the high-velocity road is obviated, as the cars turning out cross into the slow-moving vehicles at each side. This improvement was suggested by E. T. Goodrich, consulting engineer. This illustration also shows the improved method of approach to the highway based on the criticism of Coleman du Pont



At the left is a freight station at each side of the motor highway as suggested by W. E. Metzger for unloading merchandise intended for towns and cities en route. At the right Mr. Linton's idea of economical construction in hilly country is illustrated

page 1001. One of the faults of the original scheme, as pointed out by Mr. du Pont, was that the slow traffic must cross the fast on leaving the highway for a crossroad. This drawback is overcome by putting the slow traffic on the outside, as suggested by Mr. Goodrich. Another improvement is that of making the approach on the right when entering the highway from the crossroad instead of from the left, as in the original plan illustrated on page 1000. By this means the necessity of passing under the bridge when it is desired to turn to the right on the highway is obviated. This also makes a more natural entrance to the road.

W. E. Metzger advanced a very pertinent suggestion in his letter which is illustrated at the top of page 1102, namely, that suitable freight stations for unloading merchandise intended for towns and cities en route be established along the motor highway. This would enable the distribution of this merchandise by smaller trucks over roads not suitable for carrying the extremely heavy traffic from the main highway to the points in question. Mr. Metzger approved the idea that General Goethals is eminently qualified to undertake the construction of such a road connecting New York and Philadelphia as suggested by THE AUTOMOBILE. He also urged that a road of this sort be constructed to carry excessive tonnage, pointing out that there is no reason why very heavy trucks carrying trailers and loads far in excess of anything so far handled should not operate on a road of this type. Mr. Metzger expressed his confidence that the cost per ton mile over such a highway would be less than rates possible on railroads even at the present time.

W. P. Blair, secretary National Paving Brick Manufacturers' Association, recognized at once the need for such a road as suggested by THE AUTOMOBILE and urged a campaign for the education of the public as to the need of a road that is just as dependable for its service and upkeep under automobile travel as a railroad track is for a locomotive and train. Mr. Blair believes that the economic salvation of the country must come through the development of a system of roads so constructed that they will be in a continuous dependable condition for service, and feels that Eastern road engineers are less informed upon the necessity for such a system than the engineers of the Middle West. In his letter he cited instances where numerous short stretches of brick roads have given steady service for 15 or 16 years without repairs and which are still in excellent condition. Mr. Blair deplores the fact that there are no roads of this character of sufficient length to attract nation-wide attention. As an instance of our present short-sighted road policy he mentions conditions in Southern Indiana, where during the past winter roads were frozen in a smooth condition, a very unusual occurrence in this region, and the farmers rejoiced that they could send products 75 miles to market in motor trucks. Mr. Blair points out that this condition would be normal if the road system were properly constructed.

Farmers Nearly 50% Factor in Illinois Car Market

ILLINOIS farmers are increasingly good automobile buyers according to figures compiled by the office of the Secretary of State and the *Prairie Farmer*. It was shown in THE AUTOMOBILE for March 15 that Illinois has a motor vehicle registration of 251,300. A detailed analysis of these statistics indicates that the rural population is absorbing a large share of the car increase.

Of the total of motor vehicles 248,429 are privately owned; the remainder are dealers' cars. The increase in privately owned machines is indicated by the following table:

Year	Total	Increase	Year	Total	Increase
1910	31,016	....	1914	131,140	36,484
1911	38,269	7,253	1915	182,290	51,150
1912	68,012	29,743	1916	248,429	66,139
1913	94,656	26,644			

The registration figures for February and August, 1916, combined show that 49 per cent of the automobiles were registered from rural districts and 51 per cent from city sections. The rural population of Illinois, however, is but 38 per cent of the State, whereas the city dwellers are 62 per cent of the inhabitants. The rural ratio of automobiles is therefore 11 points above the rural ratio of population.

The lower-priced cars, generally speaking, showed a predominance in registration in rural districts, whereas the higher-priced cars showed a larger registration in the cities. Ford, Maxwell, Buick, Reo and Chevrolet had about 20 per cent more automobiles in the rural districts than in the cities. Overland, Studebaker, Dodge, Saxon, Mitchell and King had a slightly greater popularity in the country. Among the higher-priced vehicles, however, Locomobile, Pierce-Arrow, White, Packard and Mercer had approximately 30 per cent more city registrations than rural.

The two registration months of February and August are chosen because they represent seasons when the city and country are respectively leading in the number of cars registered. In February, 1916, the country districts took out 7122 license numbers and the city took out 12,454. In August of the same year the situation was reversed with the rural population registering 11,756 automobiles, and the urban 7754.

Illinois expects to see a steadily improving car market, especially in the rural districts. In 1916 the State collected $1,236,566.35 in automobile registration fees, all of which went to the improvement of roads.

Aero Engines Will Be All Steel

Cylinders Should Be Free to Weave—Elasticity in Engine Minimizes Stresses—Least Amount of Strongest Metal for Stressed Parts Where Heat Conditions Permit

By Charles E. Lucke

EDITOR'S NOTE: *The aeronautical engine is emerging from the stage of invention to the stage of design, and this paper, presented at the Spring Meeting of the American Society of Mechanical Engineers in Cincinnati, May 21-24, suggests steps to be taken toward the satisfactory solution of the problem.*

It resolves the engine into a light, high-tensioned steel structure, consisting of seamless tubing and forged or welded steel parts, possibly formed in drop-forge dies. To this steel stress structure are added certain members, such as the piston, exhaust valve and guide, designed primarily for heat-flow conditions and not for stresses; and certain closing members, such as the ports for the intake and exhaust, which can be very properly cast in aluminum; and the oil crankcase closure, which can be made of any material desired.

THE problem of the aeroplane engine appeals strongly to every engineer because it is a problem of the lightest power plant. The lightest weight of engine proper per horsepower is to be secured first by obtaining maximum mean effective pressure at maximum speed: in other words, the product of mean effective pressure and speed must be a maximum. At the same time the weight of metal per cylinder, or per cubic inch of cylinder displacement per working stroke must be a minimum—and with both of these factors the engine must be reliable in operation. So far, this reliability factor has been weakest, though lightness has been secured in engines good for short periods of running.

Not only must the metal weight of engine per horsepower be a minimum, but in addition the fuel weight to be carried must also be a minimum because, as can readily be seen, the fuel weight necessary for flights of any length predominates over the engine weight. For example, taking a half pound of fuel and oil per hour per horsepower as a fair value, it is readily seen how quickly that will catch up on engine weight when the latter is 4 or 5 lb. per horsepower.

In undertaking an analysis of the aeroplane-engine problem from the records, the only conclusion that can be drawn is along the line of type. Data are almost entirely lacking. On the question of general engine types, attention might be called to a few points:

The air-cooled motor has entirely failed in comparison with the water-cooled motor—the reasons are perfectly sound and secure. The two-cycle engine has given way to the four-cycle type.

Fixed Cylinders Prevail

Fixed cylinders have prevailed over rotating cylinders. Odd cylinder arrangements of queer, freaky forms have all been relegated to the scrap heap in favor of a few modern arrangements. The standard cylinder arrangements of to-day, which are the survivors of what may be called the inventive period, or at least the first inventive period, are the six and eight cylinders in line and the eight, twelve and sixteen V's.

It really appears therefore that the one valuable result of all our experience has been the selection of a few typical arrangements which we are now compelled to study, as minutely as circumstances permit, for the purpose of standardizing and mechanically perfecting these particular types as standard machines which will run as reliably as our stationary engines and which can be manufactured as economically.

Taking up each of the factors of aeroplane-engine design that seems important, in as specific a way as seems proper, the first one I wish to consider is the value of efficiency and the relation of efficiency to minimum weight.

Plotting hours of running as abscissæ against weight of engine with fuel and oil, as ordinates, for the air-cooled and the water-cooled types of motor, respectively, so that the intercept on the vertical axis represents the weight of engine metal alone, and the ordinates away from the axis represent the weight of metal plus fuel and oil, one finds that the two curves cross at some period of running beyond which, therefore, the water-cooled heavier engine, because of its lower fuel consumption, becomes lighter in comparison.

The metal weight of the water-cooled motor is about one and one-half times that of the air-cooled motor, and the slope of the combined-weight line of the latter compared with that of the former is as two is to one—that is to say, the consumption of the air-cooled motor is approximately twice that of the water-cooled motor. These facts are responsible for the crossing of the lines.

Homogeneity of Mixture

Of the conditions for efficiency which bear upon this question of fuel weight, and which have led to the selection of the water-cooled motor as a type, the first is the compression. The higher the compression the higher the efficiency, and there is no limit until preignition occurs. Statements will be found in textbooks to the effect that there is a limit, but they are the results of mistakes in interpretation, and are erroneous. The amount of compression possible is limited, however, by the metal temperature and by the temperature of the mixture as admitted. Naturally, the warmer the mixture during suction, the sooner it reaches ignition temperature by compression. Therefore, suction heating is a limit. Again, the interior metal temperature, if it is high (as it is always), may cause trouble by the contact with the mixture during compression, and some portion of the mixture may be brought to its ignition temperature by hot-wall contact long before the main mass is brought to this ignition temperature by compression alone. It requires only one such hot spot to wreck a well-laid plan.

The next factor in efficiency is the mixture quality, and in this there are the following controlling elements: first, mixture proportions. Any excess fuel means direct waste, but it also means carbonization and fouling. Excess air quickly makes the mixture practically non-burnable. Therefore, mixture proportions must be accurately controlled—more accurately than is possible with any existing carbureter. Carbureters are not yet satisfactory, and as soon as satisfactory carbureters are secured from the standpoint of proportionality of the mixture, we may expect to see a further reduction in fuel consumption and more reliable operation.

Dryness of mixture is a matter of co-ordinate importance with mixture proportions. When mixtures are wet, that is, not completely vaporized, the air and fuel cannot be uniformly distributed to the various cylinders by the manifold system. One cylinder will get a different charge from another, as can be easily proved by pressure gages. There are rarely two cylinders alike as to maximum pressures on a multi-cylinder engine using wet mixtures. Drying of the mixture will cure that fault, and also cure the carbonization that comes from the vaporization of the liquid in the presence of the burning gas when it has been admitted to the cylinder in a liquid state.

The third factor of the mixture question is homogeneity. However accurately the mixture may be adjusted as to fuel and air ratio, however carefully the mixture may be distributed, cylinder to cylinder, the fact remains that, in order to produce economical results the charge in any one cylinder must be uniform in every cubic inch of it. It is not sufficient

that the right amount of air be in the cylinder even if the fuel is vaporized, when the latter is all in one corner.

Following mixture quality, the next factor in efficiency is rate of flame propagation with reference to piston speed. It can be shown that the explosion line of the indicator card following compression must be maintained vertical for maximum efficiency. Now, the rate of propagation is the one factor that tends to hold it vertical. If the propagation rate is high enough for a given piston speed, so that the explosion line is vertical, the efficiency will be high. But should the piston speed exceed a certain value, then the explosion line will begin to lean toward the expansion line, until by and by it becomes horizontal and merges into the expansion line, with a consequent large loss of work area and low efficiency or high fuel consumption. Therefore, there is for every given mixture a limiting piston speed that cannot be exceeded without destroying efficiency, and we are now approaching that speed in aeroplane engines.

The next related factors are mean effective pressure and speed. These are the prime factors for the output of a cylinder.

If the mean effective pressure were constant, then the horsepower with reference to the speed would follow a straight line. The mean effective pressure is not constant as the speed varies, however. Therefore, plotting horsepower against speed gives a curve having the general form of concave downward and consisting of several separate portions, each worthy of study. There is usually a straight portion over a given speed range, during which the mean effective pressure is constant. For lower speeds the mean effective pressure is lower, and for higher speeds the mean effective pressure is again lower. From the point where, with increasing speed, the straight line becomes a concave-downward curve, the mean effective pressure is decreasing as speed increases, until at the point where the tangent to the curve becomes horizontal, the rate of increase of speed is exactly equal to the rate of decrease of mean effective pressure. At a little higher speed mean effective pressure decreases faster than speed increases, and finally the curve drops down toward zero power.

Volumetric Efficiency of Engine

So much for the facts. An analytical engineer cannot be content with those facts, however, but finds it necessary, if he is to apply a cure, to go behind the facts to ascertain the reasons. The first step in doing that is to determine the volumetric efficiency of the engine by measuring the air and fuel and comparing the total volume of mixture taken in with the piston displacement. If the volumetric efficiency be plotted against the speed, much light is thrown on the situation. In the first place, the volumetric efficiency falls off in the region of very low speed, where the mean effective pressure is low; it is constant over the region of constant mean effective pressure, where the horsepower-speed line is straight, and then at some high speed it again decreases. It is clear, therefore, that curvature of the horsepower-speed line is due to a corresponding variation of volumetric efficiency. It may be found, however, that at some high speed the horsepower-speed line falls before the volumetric efficiency. This calls attention to the fact that the falling off of mean effective pressure at high speeds may not be due primarily to volumetric efficiency but to other causes, and this starts a search for those causes.

The first of these causes is too slow a combustion, or too high a piston speed. That is to be corrected by adding an additional ignition source, or by moving the spark plug from a side wall to a center point. Igniting at more than one point or at a more central point will cure this defect, and again cause the dropping points of both horsepower-speed and volumetric efficiency-speed curves to lie on the same speed line.

Again, it will be found that a change in the valve setting changes this mean-effective-pressure curve at both ends, but every change in the valve setting also changes the mean effective pressure, and the volumetric efficiency is itself the direct measure of whether or not one has the best valve setting.

Now, it is curious that most people have played with cams and adjusted them back and forward by guesses, and have never bothered about the air meter, which is the only positive means of arriving at best cam forms and valve timing for sustained mean effective pressure at high speeds.

Many more analyses along the above lines could be given, but enough has been said to call attention to this most important means of studying the problem of maximum power at high speed, not only revealing what is the matter but pointing out clearly the direction in which to correct the fault.

So much for efficiency and mean effective pressure, or efficiency and horsepower per cubic foot of cylinder. Those two factors bear directly on the fuel weight to be carried and the output per cubic foot of cylinder. What will be the weight of that cubic foot of cylinder? This has to be judged both by qualitative and quantitative analyses. It is impossible to give any quantitative analysis without long mathematical treatment, so I will undertake only the qualitative analysis.

The Weight Factor

The first point in qualitatively analyzing unit metal weight of the multi-cylinder engine is to recognize that the engine can be divided laterally by planes into sections of one cylinder each. The end sections are the same as each other, but are different from the intermediate sections. Therefore, to study qualitatively the relative weights of two typical constructions, the mind must be concentrated upon these sections, each one of which includes a cylinder, a piece of frame, a piece of shaft and the other parts that go with the section.

From this point of view, consider multiplication of cylinders in line vs. radially or circumferentially. It will appear that the weight of the cylinder, piston and connecting rod is just the same no matter how the cylinders are arranged, but the frame weight and shaft weight are reduced by any multiplication. It is clear also that, other things being equal, the lighter arrangement is circumferential rather than longitudinal multiplication.

Now, going back to the history of the situation, we find every conceivable combination has been tried, but these have finally crystallized to not more than two kinds, giving the V-type engine and the engine with cylinders in line.

Considering the effect of cylinder diameter upon unit metal weight, it will appear that from the unit-weight standpoint the cylinder diameter should be as large as possible, because the wall thickness of a cylinder is always greater than necessary for the stress for other structural reasons. A 1/16-in. cylinder of steel will not be stressed over, say, 10,000 lb. per sq. in. The cylinder could be made much thinner than this and still have a good working stress if there were not other structural objections to it. This being the case, the larger the cylinder for a cubic foot of displacement the less the unit metal weight in the wall, and the only limit to large diameter is good running.

Considering the stroke, as this is increased the metal in the cylinder piles up endwise, or axially, too fast with reference to volume, and therefore for minimum unit metal weight the shorter the stroke the better. In proportion, we are using, normally, shorter strokes in aeronautical motors than in automobile engines for that reason.

Again, as affecting the metal weight, we have the connecting-rod length. Clearly, the shorter the connecting-rod the shorter the frame, and therefore the more metal saved. The only objection to the shorter connecting rod is an excessive angularity, which introduces stresses requiring metal thickening in other places.

Multiple Cylinder Engines

The number of cylinders should be as large as possible up to the point where the weight of the connecting parts has to be increased. A two-cylinder engine has less than twice the weight per cubic foot of displacement than a single cylinder, for the reason that the number of end supports for the shaft, etc., is not increased. Similarly a three-cylinder has less than three times, a four-cylinder less than four times, and so on; and the weight per cubic foot of displacement gets less and less until a certain number of cylinders—somewhere about six—is reached where the shaft diameter and the weight of the frame must be increased so as to retain the necessary stiffness, whereupon the saving in weight by multiplication is neutralized. This appears to be about the limit of saving by line multiplication.

The metal weight per cubic foot of cylinder displacement has to be taken up along the lines indicated, extending the

study to the form vs. weight of each individual member. It will appear, as one examines the forms of these individual members, that one form is clearly susceptible of less weight than another—even with the same working stresses or with equal factors of safety.

The first of these studies should be undertaken with reference to cylinders. The first cylinders built were made of cast iron, with head, cylinder and jacket cast in one piece, and the valves being arranged in a side pocket—the ordinary T- or L-head construction. It is clear that the weight of the valve pocket is detrimental. The first step in any cylinder-weight reduction, then, is to take that pocket away, retaining the cast cylinder (on the assumption that we do not know how to make any other kind) and putting the valve in the head. This results in the valve-in-head construction, which is now practically universal, but which, strange to say, it took six or seven years to realize.

Jacket Wall

A similar instance of slow realization of facts exists with reference to the cast-iron jacket wall, which has no other function than to hold water. Cast iron for that purpose, especially in an aeroplane engine, is wasteful of material, so the next step is to get rid of the cast iron. When one stops to think how it is to be done, a structural difficulty becomes apparent, and therefore one must not too readily condemn the holding on to the cast-iron jacket. The difficulty is of course the necessity of providing openings for the intake or outlet from each valve, an igniter plug hole and at least two pipe connections for the jacket, and in an aeronautical engine under heavy stress there is some driving gear which requires fastenings. This naturally tends toward the use of a casting.

Suppose such a casting is used, with inlet and one exhaust valve each with a port leading out, and such valve seating in the head which turns down to form the cylinder; then the casting may be led around the top, forming the inclosure of the head jacket and joining the several outlets and coming down outside the cylinder. The cylinder-head jacket casting ends in the form of a skirt at about the level of the valve deck, and to this end a tube jacket can be added by any one of several possible fastenings. That is the next step: cast iron for the cylinders, head and head jacket in a one-piece casting, but with sheet metal for the jacket over the cylindrical barrel. It is a logical step, but it took several years to reach it just the same.

Proceeding along the same line of weight reduction, the next step is to cut away this cast iron joining the ends of the ports and forming the wall of the head jacket, and substitute sheet metal welded to the ports by the oxygen welding system. Wherever there are connections to be made for attachment of gears, there must be some additional supports welded or brazed on. The cast-iron cylinder is still there, and with cast-iron ports.

Steel Cylinders

There is a fundamental objection to a cast-iron cylinder for aeronautical work, and it is a perfectly valid one. Cast-iron cylinders do not have to be very thick to be amply strong, so far as the gas-pressure stresses are concerned, but the fact remains that so long as they are cast iron, no one knows whether they are good cast iron inside or not, and the use of cast iron cut down to ⅛ in. in thickness incurs taking some chances. Hence attention is turned toward steel.

Drawn steel or forged steel is a reliable material and a logical selection, so designers have sought means of using it; but when one stops to think how to use a drawn-steel tube for a cylinder, and get the necessary attachments on it, one soon recognizes that the matter is not so easy as it looks. That is the reason the adoption of the steel cylinder was so long delayed.

There are now several schemes developed for steel cylinders. The first of these is a steel cylinder of a drawn tube formed without a head, screwed into a separate head carrying the ports and the head jacket cast in one piece. This is rather a satisfactory way of attaching a head, but it involves more than one difficulty. When such a screwed head is set up against the shoulder, it is not at all clear just where it is going to stop; and to secure the proper position one must either scrape the faces or shim them—neither of which is a nice job. A further objection is the considerable weight of the cast iron in a rather complicated casting, and also the inner wall of that cast iron is a stress wall, the stress of which must pass through the thread to the cylinder. There is no objection to using a casting if it is not stressed, but a casting under stress is not satisfactory and is to be retained only in the absence of something better.

Elimination of Castings

Complete elimination of castings has been tried by using all-steel and sheet metal welded together, but this did not prove satisfactory for a very interesting reason. A flat sheet-metal head on which the valves are seated will not remain flat, and a round valve seat will not stay round. Such sheet metal tends to warp out of shape, and with it the valves will not stay tight. However, the material does not break, which is something worthy of thought.

To eliminate the weld between the steel cylinder and head, another construction was developed. In this, a seamless drawn-steel shell with head just like a cartridge is used, and two holes are arranged in the head to seat the valves. It is evident that this is a structure which is sound against all kinds of stresses. It still has some of the difficulties of warping the seats, causing leakage of the valves; and when a valve leaks the amount of heat developed is tremendous. Once a valve starts to leak, it is only a question of a short time before it will be completely destroyed.

The particular construction of cylinder just described is rather difficult to attach to its jacket ports. It is interesting to note one case at least in which a satisfactory attachment has been worked out, and that is the Hispano-Suíza engine, now used on the European war front, and now also being built in this country. In this particular engine the entire outside of the cylinder is threaded, and the cylinders are screwed into an aluminum casting which is double-walled just like the cast-iron block casting of an automobile engine. The thread performs the double purpose of holding the cylinder in place and bringing its head up against the aluminum cast head which carries the ports, and also acting as a thermal bridge between the metal of the cylinder and the metal of the aluminum casting which carries the jacket water. Without the latter there would be poor thermal contact and overheating of the cylinder. While this construction is not entirely satisfactory, it is nevertheless very interesting and suggestive. It immediately calls attention to the fact that a water jacket may be made of an aluminum casting and the ports formed just as easily as in iron, the steel interior carrying the stress due to the interior gas pressures.

It is, however, quite feasible to get rid of the double aluminum wall down along the cylinder barrel into which this steel cylinder is placed and which carries the ports above, by leaving out its interior wall and retaining the outside, or even by stopping the wall just below the head as a skirt to take a short thin tube which may itself be of aluminum, ending at the bottom in a cast stuffing-box ring to act as a joint against the steel cylinder. That, so far as I know, represents the last word in this direction, the steel cylinder head being bolted up to the aluminum head-port casting at the valve-seat bases, and not just pressed up against it by a remote thread.

Cylinder Head Construction

Finally, there is to be noted the one-piece steel-forging construction for cylinder, cylinder-head, ports and ignition holes, surrounded by a sheet-metal welded jacket, a very satisfactory though expensive construction.

These heads are themselves a subject of considerable study. We have first a plain head in which the valve inside diameter is half the cylinder less the width of seat, and half the bridge between the valves. Both valves have stems pointing upward and parallel. The plain cylinder, then, which can be made of a plain seamless-drawn steel cartridge, and which is so desirable structurally, limits valve diameter, and this is a factor against it. Valve diameter is a strong influence in volumetric efficiency and weight of charge, controlling, as it does, flow-resistance conditions. Naturally, designers must get the volumetric efficiency as high as possible by keeping flow resistance as low as possible. Therefore, the tendency

is to go toward larger valves than is possible with the previous arrangement.

One variation in form for this purpose is the flat bulged head where the valve diameter is larger than before by the amount of the bulge. The flat bulged head is a very desirable thing for larger volumetric efficiency and higher mean effective pressure, but offers some difficulty in manufacture when one is making a one-piece seamless-drawn steel job, but not a serious difficulty.

Another suggestion for getting the same result is to bulge this head upward in the form of two flats and put the valves on the two inclines. It is perfectly clear that a very large increase in diameter can be secured in this way. The valve stems in this case are not parallel but diverge at any angle, and the limit is reached when the angle is 180 deg., in which case they are horizontal.

Block Arrangement of Cylinders

The question of block arrangement of cylinders and their jackets vs. separate units deserves some attention. In some cases each cylinder with its jacket and head is entirely separate. In other cases the jackets are cast or welded in a block form, around more than one cylinder—sometimes two and sometimes four, and in some cases six. It is clear that the more cylinders included in the jacket block, the less will be the weight of the jacket, because the length of the tangent to two jacket circles is less than a half circumference. But there are objections to the block, and in some cases it may not pay to use it.

In a case in point, a cast-aluminum block jacket was set down over four steel cylinders which were bolted to the frame by their usual flanges and studs. These cylinders gave trouble on the outer flanges, the end studs breaking off or pulling out. The trouble was caused by the crankcase running hot, expanding, and the aluminum block cylinder casting running cool, because it was water-jacketed, not expanding. The cylinders being bent inward tore the stud ends right out.

Another point: the steel cylinder is naturally flexible, and it belongs—in fact, the entire motor belongs—to that class of structures which should properly be termed flexible, exactly similar to bridge structures.

These flexible motors weave just as the engine of a steamship weaves. To attempt to hold one against springing is to attempt what is practically impossible. The cylinders of aeroplane engines should all be perfectly free to go as they will, and not be held on the top in any way. All the block arrangements of cylinders of the sort just described are therefore objectionable. Steel cylinders have a natural spring and give to them, and if let alone they will serve well; but attempting to secure them may result in serious distortions, or in highly localized excess stresses.

Valve Gear Construction

It was my intention to elaborate on the different arrangements of valves and valve gears, but that would take up too much space, so I will first just draw attention to some typical gears. One of these has a rocker arm overhead, worked by a push rod from a camshaft in the crankcase. In some cases this one push rod works two valves. When the valve stems are in line with the rocker fulcrum placed in the middle, each may be worked alternately. This push-and-pull may be secured by a single cam having a plus and a minus face, or by two opposed plus face cams having a plus face with a fork—the second form being far preferable. That particular form of driving the overhead valve by a rocker from a crankcase camshaft is now regarded as old-fashioned, but here is one case where there is something in favor of the old-fashioned. The new fashion is the overhead camshaft, where one camshaft, running along over a whole line of valve stems, will work them directly, or, being offset a little bit, may work through rockers, all stems being equidistant from the camshaft. When the two valves for one cylinder are on a line at right angles to the shaft, the camshaft may be placed between them, working with double rockers.

The objection to the overhead camshaft is twofold. In the first place, a camshaft mounted on separate cylinder heads exerts a restraint against their free movement. The variance of that camshaft will necessarily cause a stress, and the camshaft will be bent, and it is only a question of time when something will fail—either by wear or breakage. Again, the cam is very close to the valve stem, and the adjustment of timing is very delicate. It is difficult to adjust a valve directly driven by a cam so that it will be accurately timed, and stay timed, when a difference of 0.01 in. means several degrees.

The location of the camshaft down in the crankcase, with rods coming up to the rocker arms or levers, allows each cylinder to be entirely free, and does not interfere with its turning in any direction whatever. Also it permits the use of longer levers and a far more accurate adjustment of the timing clearances between the cam and the stem on the long reach rod; but such a reach rod should be either a tension rod or should not be used at all. A push rod in a place like that seems to be fundamentally wrong. Here is a case of a long column of thickness of about half one's little finger, which is, in many cases, opening a valve—an exhaust valve—against an internal pressure of 40 lb. per sq. in., and a diameter of 2 in. or more, and, in addition, overcoming all the inertia of the gear and valve at perhaps 2500 r.p.m. That is not a proper function for a long column, but is a perfectly proper function for a tension rod, or steel wire, and why no one has put a steel wire between the valve stem and camshaft, which will allow the whole structure to go the way it wants to, instead of abandoning the crankcase camshaft, is more than I can see. Of course, the block construction is more favorable to the overhead camshaft but it has not all the advantages.

Valve Timing

Coming now to the question of valves, everyone knows that it is of no consequence to lift a poppet valve more than one-quarter of its diameter. It is also true that the valve will work better, and the volumetric efficiency and mean effective pressure be better, the larger the diameter of the valve and the smaller the lift. That is: the valve should not approach the quarter-diameter lift. That condition conforms to good principles of gaseous flow.

It is also a fact that the timing of the valves on the high speeds in aeroplane engines, when one is desirous of getting the largest possible mean effective pressure, is a matter of basic importance. In no case should an inlet valve close sooner than 20 deg. late, and the amount more than 20 deg. late must still be determined experimentally for each machine, because the porting and manifold is different on each machine and no general formula has yet been found. Likewise the exhaust opening must be 45 deg. plus something ahead; the exhaust closing 5 deg. late plus something, etc. The inlet opening is the only period that does not seem to matter.

Suppose one had a valve lift of 0.4 in.—which would be reasonable for one of these motors—the valve is supposed to lift 0.4 in. and close again in the open period of the valve, which we may assume is 200 deg. in round numbers. If one examines that 0.4 in. lift and 200 deg. of crank angle, one finds that a variation of 0.01 in. in the lift corresponds to 5 deg. of crank-angle timing effect. It is clear, therefore, that with valve lifts of the order we are dealing with, in facing the problem of accurate timing we are running into a question of very great accuracy of dimensions, where a difference of 0.01 in. in any part between the cam and the valve stem means a difference of 5 deg. in time, and that may mean a loss of 5 per cent in power.

A valve is normally made of a quite thin disk with a small-diameter stem joined by a fillet. It sits in a seat supposedly water-cooled. It is a stress member, and is normally designed for stress. Designers talk about Grashof's formulæ for flat plates as the basis for its design, but that has nothing to do with the case.

Keeping Valve Cool

These valves, designed according to this formula, will burn out. If they are designed according to the flat-plate formula they are quite thin, and their stems also—when calculated for compression loads. Consider heat being added to the outside face of that whole disk, and at a rate that is not equalled in any other structure that we have anything to do with. In the case of the exhaust valve there is some heat

added on the other side, too, and when the valve opens there is a tremendous increase on the back, as is also true when the valve leaks. But excluding that extra heat, and considering only the heat added on the flat of the disk, the valve can attain a steady state of temperature only when the heat is being disposed of at a rate equal to that at which it is received. Where is the heat going to go? How is it going to get out? It is perfectly evident that the problem of keeping the valve cool is entirely a problem of providing for getting the heat out, because there is no control over what comes in. The heat flow is radially inward, then axially upward to a stem bearing. After the heat gets up the stem, it turns off through the stem bearing to the water.

Stem Thickness and Disk Face

When it is remembered that the conductivity of a gas film is ever so much less than the conductivity of the metal through which the heat is flowing, and that the same is true of the water which must ultimately receive it, it is perfectly clear that the amount of area in the stem guide must be very large in proportion to the area of this stem circle carrying the heat up to it, and the ratio of one to the other should be based somewhat on the conductivities, with due regard to gas-, oil- and water-film thicknesses. Also, the heat received on the disk must pass through the cylinder of metal constituting the stem.

Therefore, the stem thickness must bear a logical relation to the disk face, and the thickness of the face should regularly increase toward the center. If one followed this out, one could easily develop a rational form for valve based not on stresses but on heat flow.

The ratio of the conducting area to the heating surface becomes the prime variable, and it is perfectly evident that that ratio ought to be the same all through one piece of metal itself, and ought to be increased when the heat must cross a bridge, as at the stem guide where there is a film of oil or dead gas, by an amount representing the ratio of thermal resistances. If one does that, he is carrying through the principle of establishing a regular temperature gradient from the most distant point; and it only requires one or two experiments in that direction to decide what metal to use, and what shape, and how close it ought to fit, in order that any fixed temperature will not be exceeded at the hottest part. So long as it remains below a red heat a valve is all right, but as soon as it attains a red heat it will first oxidize and warp and then will cause preignition.

This thermal study of a valve has not been undertaken by anyone in the shops. It is one of the things that the scientific men are contributing to this problem, but it is now about to be put to practical use. The same situation exists with respect to the piston, as the following shows:

The ordinary piston, as built for aeronautical motors, has been a failure; and even in the best motors to-day I venture to say that, next to the exhaust valve, the piston is the source of greatest trouble. I put it before the exhaust valve. I think more accidents and trouble can be traced directly to pistons than any other single part of the engine structure, and yet pistons have been entirely neglected from this thermal standpoint. In the first place, the aeronautical man, in starting out to build his aeroplane on the automobile model, had in mind only one thing—to take metal away from every possible place with the idea that the metal was there only for stress purposes and might be taken away as long as the stress did not go above a certain value. What happened? In the first place, the piston was cut off from one and one-half diameters long to less than one diameter long, which reduced the contact between the piston barrel and the cylinder. Not being satisfied with that, the early designer bored holes in the piston and then cut the head down until it was ⅛ in. in maximum thickness, and frequently only 1/16 in. across the top. So far as stresses were concerned the piston thus reduced was all right, but it ran hot and soon gave trouble.

Piston Heat Dissipation

Consider the piston from the standpoint of heat dissipation, and something surprising follows the logic of the analysis. The piston is receiving heat all over the top at a very high rate. Where is the heat going? It must go out through the barrel walls and the oil film of the cylinder—that is the only place it can go.

It is perfectly clear that the heat received within a circle drawn concentrically on the head must pass radially outward through a cylindrical surface equal to the circumference of the circle multiplied by the head thickness at that point. The heat received within a larger circle drawn on the head, passing also radially outward, must have a larger head thickness at its circumference. If the temperature is not to get unduly high, then the head thickness must regularly increase from center outward, so that the metal-conducting area bears a constant ratio to the area of the heat-receiving circle to control the temperature gradient from center to edge. The principle is the same as is used in designing copper electrical conductors to control the voltage drop. It can be shown by a simple equation that the thickness ought to increase on a straight line.

When the heat gets to the edge, it is clear that it must flow down the piston barrel. Therefore, there ought to be as much metal behind the first ring as the thickness of the head at the inside edge of the barrel. Practically no heat can get through the ring, this being a floating member. Then the barrel thickness can be regularly decreased toward the open end, to control the temperature gradient from end to end. It is also clear that the more surface there is around the barrel, and the better the fit, the easier it is to establish a low-temperature gradient between piston barrel and cylinder wall, providing there is sufficient conducting metal in the piston walls, head and barrel. From considerations of that character, backed up by any number of broken and burnt pistons, it is about time we stopped cutting the metal out of the pistons and began putting in considerably more metal. The additional weight is not going to injure the motor at all, but will permanently have the effect of enabling it to run longer periods of time.

A qualitative analysis of frames is also worth while. The frame of the aeronautical motor has been regarded as a thing that nobody has to be bothered about. It was a crankcase and of course we had lots of crankcases. Automobile crankcases had been made in great numbers and variety, and it seemed a simple thing to create an aeronautical-motor crankcase from that of an automobile motor.

Crankcase Weight Reduction

Now, it is a fundamental fact that if one is going to reduce the metal weight of a structure such as this, to a minimum, every piece of metal should be required to carry a very heavy stress—as heavy a stress as possible, and do it all the time. The basic principle, then, of weight reduction, after the thermal considerations have been disposed of, and the conditions for high mean effective pressure and thermal efficiency properly met, is to make the metal carry real loads. That is not to be accomplished with the ordinary crankcase construction, because the crankcase is a reasonably heavily stressed member, and is subjected to complicated sets of stresses that cannot be opposed with any economy of metal weight by a common casting of box form—which is all that the ordinary crankcase is.

The old-style crankcase, of upper and lower halves, formed a box with holes on top to take the cylinders. The lower half of the box carried webs, which in turn carried the bearings with top caps. If one started off with the idea of designing a structure as little adapted to the stress conditions as possible, this is about what he would get. Consider the fact that the stress due to the gas pressures is always upward, producing tension in the cylinder and its fastening to the frame that is carried out along the flat top of the box as a beam load and down along the upper side walls as tension; then through the parting joint to the lower side walls, and then through the webs as beams from both sides to the main bearing and shaft, where it finally ends. Coming around like that is an excellent example of indirectness of stress transmission and consequent demand for the maximum of metal.

Consider also that the crankcase is stressed in another way, in that it has in the four-cylinder motor a pair of cranks acting downward between a pair acting upward, so

that there is a rotating radial centrifugal load due to both rotating masses and the inertia of the reciprocating parts. This sort of loading puts on the crankcase the duty of a beam, but in which the direction of loading rotates. It would appear that the box structure is rather better for the beam-load condition than it is for this tension condition.

Slowly these ideas have percolated, and the effects are to be seen. The first direct effect is noticed when this bottom web is eliminated, and the bottom crankcase member ceases to be a stressed member, and becomes merely what it ought to be—a cover. The web is introduced in the top half, and the bearing now has bottom bearing caps held by studs in the top web. Now the gas pressure stress can come straight down through the webs. This, however, is not as satisfactory as it might be, because each web is a plate subjected to the same kind of stresses as a truss is. The next suggestion, therefore, is to build it truss-like; and we find top-web castings taking truss forms, cutting out holes in the unstressed section of the web member. That is an example of appreciation of the nature of the problem. The next step, however, shows rather more intelligence, where there is substituted for the cast web member a high-tension steel long-bolt member running up through a hole in the web. That bolt takes a bearing cap on one end and takes the cylinder flange on the other end. This represents the last word to-day.

It is my belief that the next step should be to eliminate the cast-aluminum webbed box member entirely, and to build the whole thing of direct truss form, using nothing but steel. Furthermore, I do not hesitate to say that it is my belief, founded upon the study of practice and on some analyses, that no member of the aeronautical engine that is subjected to heavy stress should be anything but steel, except when that member is subjected to heat-carrying conditions and must be designed for heat-carrying, rather than stress resistance, in which case it will be found that there is more than enough metal for stress. This leaves only one other class of member, which is the inclosing member and which can be made of whatever suggests itself.

So, to my mind, the aeronautical engine is emerging from the stage of invention to the stage of design, as a light, high-tensioned steel structure, consisting of seamless tubing and forged or welded steel parts, possibly formed in drop-forge dies. Add to that steel-stress structure certain members, such as the piston, exhaust valve and guide, designed primarily for heat-flow conditions and not for stresses. Add to that again, certain closing members, such as the ports for the intake and exhaust, which can be very properly cast in aluminum; and the oil crankcase closure, which can be made of anything you please.

Now, in the course of this designing, it is necessary to build, test, analyze results and repeat. One can argue, as I have done, at very great length from the standpoint of qualitative analysis; but that sort of analysis, however nicely it leads into certain directions, as shown, does not give the right answer. It requires in addition a quantitative analysis, which can only be obtained experimentally, and which is the ultimate step which we, as engineers, are in duty bound to demand.

Unity Device Converts Ford Into Truck in 2 Hr.

THE Unity Motor Truck Co., Cleveland, has put on the market a Ford converter, called the Unity truck, selling for $150, meeting the demand for a light 1250-lb. truck or delivery wagon. It is claimed that the converter can be put on a Ford in 2 hr. without drilling a single hole. The gear ratio of the Unity truck remains the same, 3.63 to 1. A few other features include a 100-in. overall frame, 39 in. wide, providing a 7-ft. carrying frame without overhang, and semi-elliptic springs under the body. Unity construction puts no weight on the rear axle, carrying it on the regular Ford perch and housing which supports the spring shackles. While the rear axle is relieved of all weight, it is strengthened and braced by two heavy steel rods that cradle the differential and assure perfect alignment of the rear axle and wheels.

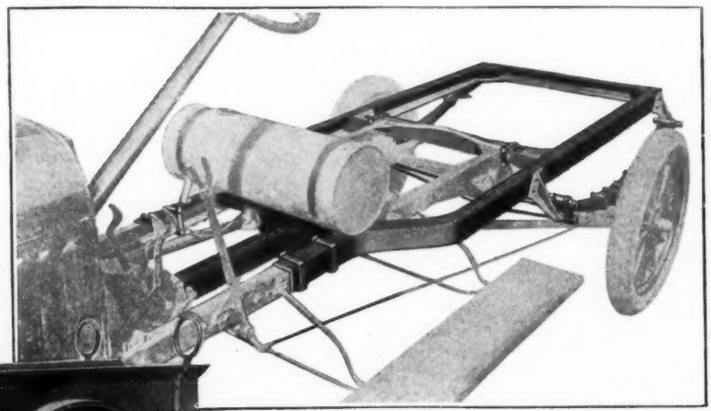
The Unity frame is of pressed steel. It is fastened to the Ford frame by six clamps which are clamped to the side rails and rear cross member of the Ford frame. It is further reinforced by two cross members, one of which is clamped and bolted to the Ford frame.

The original Ford driveshaft is moved back intact. A heat-treated extension shaft inclosed in a torsion tube and fitted with a Hyatt roller bearing is furnished. The angle of drive from the universal joint to the differential is not changed.

Steps in Repairing Blowouts

TWO methods are commonly used, the outside and the inside, of which the outside is the more efficient. There are three points in a tire where strain and flexing action are most prominent, the center line of the tread surface and the edges of the tread above the beads. To obtain the necessary strength, plies or steps of fabric should not be ended at these points.

At the right is the rear section of a Ford chassis on which the Unity device has been applied to convert the car into a truck. The operation is said to be performed in 2 hr. without drilling any holes, as the Unity frame is secured to the Ford frame by six clamps. The Unity device is indicated by the dark portions



At the left is a Ford converted into a light truck by equipment with the Unity device and mounting an open body for plumbing work. The original Ford drive shaft is used in connection with an extension shaft inclosed in the torsion tube as illustrated above

4,000,000 Prospects in China

Foreign Trade Department

1200 Cars Now in Use in Country of 400,000,000 Population—Roads Are Few, But If System Were Developed Motor Vehicles Would Multiply Rapidly

By Allen Sinsheimer

CHINA has purchased 1200 automobiles through its buying public. At least 1 per cent of its total population of 400,000,000, which means 4,000,000, can be sold automobiles if properly approached. And the American manufacturer who speedily adopts an intelligently aggressive policy, secures concessions from the Chinese government, and develops the highways in that country can be assured that he will earn the undying gratitude and the automobile business of the Chinese people. This is the view of Charles Denby, export manager for the Hupp Motor Car Co., Detroit, and an individual who has enjoyed a wide experience in Chinese affairs.

Roads Are Few

Mr. Denby states that the roads of China are few, and in the main impassable. The city of Pekin, for example, has a population of 600,000, and has less than 16 miles of roads within its limits, and but 12 miles outside the boundaries extending to a near-by palace. Many other cities are even less fortunate; and northern China, where the climate is dry for 9 months each year, and the travel would afford beautiful scenery, has no roads that automobiles could tour.

The Chinese are lovers of luxuries. They welcomed the phonograph and other American amusements. They are particularly fond of travel, as is evidenced by the heavy travel over the Chinese railroads. Yet but 1200 own automobiles, and the cause lies in the lack of roads. The average better-class Chinaman is fairly wealthy, sufficiently so to afford a moderately priced car. Silver, the Chinese medium, has advanced considerably in value in recent years; and the tael, which was formerly worth 55 cents in American money, is now valued at 86 cents.

Mr. Denby feels that the American makers do not appreciate the remarkable opportunities that China offers. France, he stated, despite the war and the present heavy drain upon its resources, finds China of such great moment that it is using a part of its revenue for further Chinese development.

CHARLES DENBY

Export manager for the Hupp Motor Car Co., recently returned from China

"If an American automobile maker or a group of American automobile manufacturers were to form a company under American charter, and would secure concessions, which I know can be had, from the Chinese government, they could build roads through China and dictate what automobiles could operate on them. They could call the road by the name of their product, if they wished to do so, and could with a little effort secure a large share of the business.

"The American manufacturers do not appreciate the opportunities that are lying dormant in China, and which will soon be grasped by foreign makers of automobiles if we do not awaken. British and French capital is active even now; somebody is going to secure this vast business, and it will not be the United States unless its manufacturers are willing to give time and attention immediately to China.

Great Opportunities

"The opportunities are wonderful. There are cities of 1,000,000 to 2,000,000 population where there are no roads extending either through the cities or out to the surrounding country, and the manufacturer who develops these roads can secure extensive markets for his product. The Chinaman delights in travel for pleasure, and would welcome the travel field produced by a combination of a low-priced car and good roads."

Mr. Denby stated further that the Chinese would themselves invest in a company organized by Americans for road building, and said that the Chinamen have learned to invest in many American securities.

The cars that would be most suited to Chinese conditions would have to possess low gasoline consumption. Gasoline is 50 cents a gallon. They would have to be all-year cars, because of the dust and high winds. Other improvements peculiar to China would develop through experiments.

The Chinese learn rapidly, become good repairmen, and would, without doubt, take quickly to the automobile.

High-Compression, Heavy-Oil Engine Development Predicted

H. G. Chatain Analyzes Utilization of Heavy Fuels in Diesel Type Engines in Paper Read Before Metropolitan S. A. E.—½ Lb. of Fuel Per Brake Horsepower Hour

[EDITOR'S NOTE—With the price of gasoline constantly going higher and no relief in sight, the paper read by Henri G. Chatain before the Metropolitan section of the S. A. E., May 17, on "Treatment of Hydrocarbon Fuels," is of particular interest. Mr. Chatain's paper, which analyzes the use of heavy fuels in engines of the Diesel type, is published in part here.

HIGH-COMPRESSION, heavy-oil engines in all probability will come into use for passenger and commercial vehicles and also for airplanes. Present types are not yet suitable for these uses, but there is no really inherent reason why an engine of this kind could not be built and serve satisfactorily.

This is the prophecy made by Henri G. Chatain, of the General Electric Co., at the monthly meeting of the Metropolitan section of the Society of Automotive Engineers May 17 in a paper entitled "Treatment of Hydrocarbon Fuels." The paper was essentially an analysis of the manner in which liquid fuels are transformed into energy within the cylinders of an internal combustion engine of the Diesel type.

The production of a Diesel type engine for present land and air vehicle propulsion requires that the basic principles underlying existing types be carried out in proper manner; that a careful study be made of all mechanical parts, and that there be a redesign along rational lines of such devices as now are used for carbureting or breaking up the fuel and rendering it fit to be used in the engine.

Chatain pointed out that when it becomes thoroughly understood that these motors can be made to operate on less than ½ lb. of fuel per brake horsepower hour and the price of existing fuels continues to increase, a motor of this kind becomes something more than a possibility.

Such Engines in Use in Germany

In fact, engines of this type already are in use in Germany. In the discussion following the reading of a paper by Philip Lane Scott on the design and construction of the Junkers engine, which was abstracted last week in THE AUTOMOBILE, Scott stated that a Junkers airplane engine has been constructed in Germany and has developed 1 hp. per 3½ lb. of weight.

Both Scott and Chatain seemed agreed that there are far greater possibilities in the development of a Diesel type or semi-Diesel type of engine for road and air vehicle propulsion than there is in the development of devices for the use of kerosene in present engines, or engines slightly modified to use this fuel.

In response to a question Chatain stated that he had not made any experiments in the use of denatured alcohol for the reason that there had been no wide demand for the use of this fuel. He stated further that, owing to existing laws which require that denatured alcohol remain in bonded warehouses for a considerable time, the small producer is virtually cut off from this market. Until these laws are amended it is entirely too expensive for small producers to turn waste material into alcohol.

In Chatain's opinion, the only logical way to use kerosene is to employ some device that converts the fuel into a fixed gas, rather than into a fog, as is the case at present. With the fog, he stated, it is not possible to obtain that degree of oxidization which is necessary for efficient combustion. A good device would have to operate much like a gas producer.

The kerosene carbureter, which is essentially the same as a gasoline device, he said, is entirely inadequate for the reason that applying heat in the manner it is now applied reduces the efficiency of the engine. It was suggested that a more logical solution of the problem appeared to be the distillation of crude at a somewhat higher temperature so as to utilize much of the content which now comes off in the form of commercial kerosene.

Chatain said, in part, as follows:

With the pressing demand of the early days for ever increasing horsepower in automobile engines, necessity made it imperative that some device be produced which would be compact and simple for the purpose of carbureting the air. Even if the volatile hydrocarbons had prevailed, a surface curbureter for a 40-hp. or 50-hp. engine would have been prohibitive, due to its bulk alone.

Carbureter Design Complicated

The jet carbureter was accordingly brought out and had for its basic principle of operation the issuing of one or more small streams of gasoline into a rapidly moving mass of air. The inertia of the jet of gasoline in conjunction with the moving body of air possessed sufficient force so that the liquid was, strictly speaking, mechanically broken up and turned from a liquid to what might be termed a fog.

The design of this apparently simple piece of apparatus is indeed very complicated, so much so that in over 20 years' time with innumerable people of intelligence working upon the problem it is still to-day, although practical, far from being a comparatively perfect piece of apparatus. It would be well to thoroughly understand the elements which go to compose the gas desired and their proportions and also to explain at some length how these proportions are approximately obtained in the modern jet carbureter.

It is well known, for example, that the gas formed by the mixture of air and the fog of gasoline is as highly explosive as possible when it is composed in the environ of fifteen parts of air for one part of gasoline. This is proportioned by weight at atmospheric pressure. Fifteen therefore for the sake of argument may be termed a constant. Above or below this figure the carburetion is not so good. Explosion, it is true, may occur, but the gas becomes poor, and obviously the power of the engine falls off. The disproportionate mixture may be carried to such a point that explosion does not occur at all.

It is also well known that this constant varies with the combustible used. For illustration, as stated above, it is necessary to have fifteen parts of air to one part of gasoline, but it is necessary to have nine parts of air to one part of ethel alcohol, or seven parts of air to one part of methyl alcohol, and so on for the various fuels.

So that the carburetion of the air by the gasoline is always as good as possible, it is necessary that the above-mentioned

proportions be kept constant through the range of speed and load and combinations thereof of the motor, it being understood that the changes in speed and in load produce a radical varying effect upon the carbureter as the varying amount of air aspirated decreases or increases the depression or drop in pressure at the gasoline jet. Compensating for this varying depression has never been solved in an entirely satisfactory manner.

Finding a Practical Mixture

The first question which has confronted the constructor has always been this curious feature of the carbureter. That is, to find a practical mean between gasoline and air at various speeds, loads, and combinations thereof.

The operator then, as well as now, could not be asked to make running adjustments by hand. It was necessary then first to find a means and method to make permanent this constant, and, second, to charge the motor with keeping this permanency of mixture.

It was thought that this ratio of fifteen to one would necessarily stay constant, even with the variations in the functioning of the motor, and that the relative value of the depression caused by the aspiration of the motor would remain constant with relation to the gasoline and keep the proper proportions, the orifices admitting the air and gasoline to remain fixed.

This assumption was an error. Air is a gas. Gasoline is a liquid. The masses of the two bodies are therefore not equal, and therefore the inertia is unequal. As the liquid is put in motion, caused by the depression in the intake pipe, it has an inertia greater than that of air, and the liquid therefore continues to come out of the orifices a moment or two after the load has been thrown off or the speed of the motor reduced, while, on the contrary, the air issuing through the orifices in the vicinity of the gasoline jet ceases instantly, or nearly so, upon the reduction of speed or load of the motor.

The permanency of the constant would exist without any special apparatus if we were dealing with two gases, for instance, air and illuminating gas or natural gas. The mixture of the two gases would have an inertia quite the same, it would come out of the respective orifices in a fixed proportion, once they were adjusted for various speeds and loads of the motor.

The conclusion was arrived at therefore that with this type of carbureter some form of device would have to be utilized to admit more or less air and thereby increase or decrease the depression in the intake pipe so as to keep the constant in proper proportion. Hand regulation of the above-mentioned device was at first resorted to, but, as I have already stated, this was found to be impracticable, as one never knew exactly when the carbureter was adjusted so as to maintain the proper proportions of fifteen to one, with the net result that at times the motor ran properly, but more often it did not.

To the early French investigators must be given the credit for having developed the prototype of the modern carbureter, a device which is well known to-day, making itself manifest in various and diverse arrangements in the way of auxiliary valves to admit air, auxiliary nozzles to admit gasoline, automatic and hand chokes placed in diverse positions.

Still Far from Perfection

Experience gained through 20 years of carbureter building has brought this piece of apparatus up to a point which can be considered standard, but still a considerable distance away from being perfected for the following reasons:

It does not produce what might be termed a gas.

Forces utilized in its functioning are insufficiently powerful to utilize a fuel other than the comparatively volatile combustibles.

It is the contention of the writer that, broadly speaking, it is necessary to decrease to a minimum the so-called viscosity of the combustible before the best results can be obtained in a given cylinder. This statement it is appreciated is somewhat ambiguous. It is conceded, but it is believed that a further dissertation on the breaking up of combustibles will suffice to make the writer's contention clear.

As most lines of endeavor and effort are conducted along the path of least resistance, it is noteworthy and curious to understand just why the principal effort outside of the utilization of the very volatile hydrocarbons, such as gasoline, has been made along the lines of utilizing heavy hydrocarbons, such as fuel oil, various crude petroleums, tar oils, etc., etc., rather than a concerted and well defined effort to utilize what is commercially known as kerosene.

It is probably due to the fact that the market price of gasoline has been, up to the present year or so, comparatively so low as to discourage endeavor in the field just suggested.

Surely conditions are changing and will change so as to make it imperative that the next combustible along the path of least resistance, namely kerosene, will be utilized.

This brings us to a consideration of what has actually been accomplished in the utilization of kerosene.

Utilization of Kerosene

The demands to solve this problem have resulted in certain distinct types of devices, which are as follows:

1—The commonly accepted type of gasoline jet carbureter with heat applied in various ways:

a. To the fuel itself
b. To the air
c. Heated jacket
d. Heated jacket plus heated intake pipe.

2—Devices which will partly burn the fuel before it is admitted to the intake pipe, forming a more or less fixed gas intermingling to a greater or less extent with the vapor of the combustible.

3—Devices which admit the combustible in the cylinder direct, the valves of the motor being so regulated as to cause a partial vacuum in the cylinder prior to the admission of the combustible.

4—Where the combustible is impinged by means of a pump, or otherwise, directly upon a hot surface in the interior of the cylinder, or a chamber adjacent thereto.

5—Devices which raise the temperature of the combustible to the boiling point producing vapor but in no sense of the word a fixed gas.

Criticisms of Present Methods

1—To criticize the endeavors formulative of the first group is a comparatively simple matter. The investigators obviously took the existing device and have tried to apply it to a fuel which is in many respects distinctly different from gasoline or the fuel for which the device was designed and intended. Primarily the forces manifest in the gasoline carbureter are absolutely insufficient to turn kerosene into a fog, or rather put it in a condition such that it would commingle with the oxygen in the cylinder and be readily inflammable.

Secondly, the complication of heat is essentially the same as applying another force to destroy the viscosity of the combustible, and when this has been judiciously applied certain results have been obtained which are for certain purposes at least encouraging, but so far impracticable when the motor is to be considered as applicable to an automobile or kindred service. The troubles are many. The source of supply of the heat is inconstant. It is difficult to regulate it. Its action lags, that is to say, when a sudden demand is made upon the motor for increased combustible, the heat requisite is not available until the combustible is actually burnt, and it is perfectly obvious that sudden variations in load and speed cannot be well taken care of by this process.

In starting the motor it is necessary to derive heat from an exterior source. This is inconvenient and irksome.

For stationary engines, certain classes of boats or other applications, where a skilled attendant is available, this type of gas-making device has had and is having success. Again it would appear that this type of device presents insufficient force to accomplish the results desired.

2—The second type, or what might briefly be called the fixed gas type, presents many attractive features. In starting all that is necessary is to ignite, by means of a wick, part of the combustible, no other preheating being necessary. With proper regulation of the amount of fuel actually set afire and relying upon the aspiration of the motor, a reasonably permanent gas can be formed and regulated under the adverse conditions under which we are working. The power

to destroy the viscosity of the oil is plainly evident. It is set afire and permitted to burn. No preheating devices are necessary.

The writer has actually operated a device of this character in extremely cold weather with gratifying results. We certainly may look forward to future developments. It would be well to bear in mind, however, that the efficiency of the motor will probably be decreased with this type of device, as the gas produced under the circumstances is such that moderately low compression is desired.

3—An engine utilizing this principle was devised in France some few years ago, and, although it did not meet with immediate success, the principle involved was novel and attractive.

It is not a foregone conclusion that the forces obtaining in the ordinary intake pipe, comparable with a depression of a certain pressure per square inch would have the same result in breaking up the fuel as a corresponding and similar vacuum produced in the cylinder proper, fuel being admitted therein directly.

A device was experimented with to some extent by the writer, and although it was possible to start an engine cold, the cycle of events occurring in the cylinder was so divergent from normal, due to the very late opening of the intake valve, that the experiments were discarded, and no great amount of work done along these lines, also for the reason that the scheme introduced what appeared to be excessive complication.

4—This method of utilization of combustible is well known. It is not necessary to discuss it at great length here, as it has the insurmountable fault that it is necessary to preheat the engine, and this it would appear can only be done in a practical manner by means of some form of blow torch, requiring several minutes to heat the parts sufficiently so as to make starting certain. If a multi-cylinder engine, such as the prevailing types of the day, were used, the complication and trouble would make the scheme highly undesirable.

5—About the same criticism can be made for this scheme as for No. 4. It is hardly worthy of further investigation for our purpose. The idea has about all of the attendant disadvantages of the steam boiler with a few added.

Use of Heavy Hydrocarbons

In passing from the utilization of kerosene, the next logical step is to the very heavy hydrocarbons, and although there is still a great deal to be accomplished in this field, much has already been done.

For comparatively large powers and for diverse purposes, the high compression oil engines—I refer now to engines whose compression goes to 500 lb. per square inch or thereabouts—is an accomplished fact, hundreds of thousands of horsepower being in daily use throughout the world. A brief description of its principle, but only a brief description is in order.

The four-stroke cycle and two-stroke cycle are used, and have their advocates, who claim their respective superiorities. Pure air is taken or admitted to the interior of the cylinder. This is compressed to 500 lb. to the square inch or thereabouts and at a point approximating the upper dead center of the piston or slightly before, fuel is injected in the form of a fog or fine spray and upon coming in contact or commingling with the highly heated air in the interior of the cylinder, inflammation results. This obviously increases the temperature of the air, which in turn is expanded.

Up to the present time the accepted form is the air injector. The function of the injector is to receive a definite quantity of combustible, this per cycle, and usually propelled to the injector by means of some form of pump.

It is quite immaterial at what portion of the working cycle of the engine this oil is delivered to the injector, suffice that it go there in proper quantity and in synchronism with the rotative speed. Its quantity is a function of the load on the engine. To this same injector device, air is led from a pump or suitable container under pressure varying in practice usually from 800 lb. to 1300 lb. per square inch.

The injector is also equipped with a cam or otherwise actuated needle valve. This needle valve being opened on or slightly before the upper dead center of the piston, permits the contents of the injector to come out in the form of fog or fine spray. There is still another small portion of the injector, but still of great importance, and this is known as the flame plate. Its function is to divert in the proper direction the incoming spray or fog from the injector. This is usually accomplished by one or several small holes of suitable size pointing in the proper direction.

Distribution Must Be Uniform

This, pointing in the proper direction, brings up a very important point in regard to utilizing combustible in this manner. It is obviously essential that the entire combustion chamber should be filled simultaneously or as near so as possible with the combustible.

If the flame plate was so arranged so as to distribute the combustible in only one-half of the cylinder, the power and output of the engine would go down to an appreciable extent.

In this respect I wish to clearly point out that the high compression engine is distinctly different from the engines utilizing fuel which has been admitted prior to the compression stroke. In this instance the compression stroke serves to a great extent to thoroughly mix the combustible with the air and presents a homogeneous mass at the time the inflammation is started.

The development of the art is such that with the injector, as described above, and commonly used, it is possible to operate an engine at rotative speeds as high as 550 r.p.m. or thereabouts. Although fulfilling the writer's theory in regard to great power to destroy the viscosity of the oil, the accepted type of injector to-day operating a 1000-lb. pressure per square inch is still incapable of furnishing the necessary force to operate properly at speeds higher than stated above.

The time necessary for the oil and air to go through the circuitous passages of the holes of the flame plate, all of which are apparently essential in the breaking up of the fuel, is excessive when we contemplate utilizing this device for high rotative speeds or in engines for automotive purposes.

It is essential in the design of an injector to so construct it that oil will make its way to the combustion chamber in advance of the injection air. The reason for this will be better understood when one considers that the injection air is expanded from 1000 lb. per square inch down to 500 lb. with attendant refrigerating effect, which tends to decrease the temperature of the immediate surrounding air and render combustion slower and less positive.

A number of attempts have been made to discard the injection air and resort to solid injection. Nothing of this character has ever been attempted in this country, at least so I believe. An English firm of note, however, has apparently carried this line of investigation to a point where it is at least workable. Although from reports upon the subject it would appear that the economy of their engines is lower than is customary and that they experience a smoky exhaust with attendant difficulties which result from imperfect combustion.

The Open Nozzle Injector

There is another device known as the open nozzle injector. Its operation is as follows: Into a small declivity or pocket in the cylinder the fuel is pumped in the requisite amount. Impinging upon this oil is air of 1000 lb. pressure per square inch, the needle valve of which is opened at the proper time on the stroke.

This causes the fuel to be broken up and violently thrown around the combustion chamber.

This scheme has at least one great advantage, that no oil passes through the needle valve, and therefore it is not susceptible to clogging.

There is one very important feature in regard to internal combustion engines of the high compression type which apparently so far has not been given a great deal of thought, and that is that with the most approved type of injector and all in excellent operative condition it is still necessary to have some 40 per cent to 50 per cent of excess air in the cylinder to produce perfect combustion. If the engine is overloaded, smoky exhaust is produced, meaning that the inflammation is not completed during the working stroke. Obviously this is a waste of fuel, not to mention the deterimental effects produced upon the mechanical parts of the engine.

This is indeed a most important point, as it is quite obvious that if a greater percentage of the air which is taken in per cycle could be carburetted and utilized, the size of the engine could be diminished.

It has long been the belief of the writer that a big step in advance is due and is coming when other means will be found and devised for subdividing the incoming fuel into finer particles than is done at present, permitting each tiny particle to become thoroughly oxygenated in the shortest possible time.

It is possible that an entirely different shaped combustion chamber from the existing types should be used; that is, a combustion chamber which will be constructed in a shape to conform with the jet of incoming fuel.

The writer has been asked the question many times, if it would not be possible to apply the existing principles of the high compression oil engines to motors which would be suitable for automobiles and kindred purposes.

Existing Engines Not Suitable

Invariably the question has been answered that the existing types so far are not applicable, but it must be frankly admitted that there is no really inherent reason why a motor could not be built which would apply. It means carrying out in a proper manner the basic principles underlying the existing types, but it also means a careful study of all the mechanical parts, and a redesign along rational lines of the device now used for carbureting or breaking up the fuel and rendering it fit to be used in the motor.

When it becomes thoroughly understood that these motors can be made to operate for less than ½ lb. of fuel per brake horsepower per hour and the price of existing fuels becomes higher, the proposed idea will come about and become a reality.

Some form of two-stroke engine would adapt itself better for this class of service than the four-stroke cycle. The reason for this is that in the two-stroke cycle engine of this category the compression pressures used of 500 lb. per sq. in. and over would be sufficient to counteract the inertia of the reciprocating parts with the result that the pressures on the piston pins and crank pins will always be downward or in the same direction.

As this will be the case, the trouble of taking up bearings for quiet operation would be done away with. The same could be permitted to wear to a considerable extent before requiring attention. The fact that this pressure would always be in the same direction introduces a problem in lubrication, but this can and has been successfully overcome.

It would appear that it would be advisable to experiment and investigate along the lines of solid injection, utilizing extremely high pressure, possibly as high as 6000 lb. or 7000 lb. to the square inch rather than go to the complication of utilizing air for this purpose, with its attendant multiple-stage compressor and paraphernalia.

Preparation of Fuel

The writer knows of no effort that has been made of especially preparing fuel prior to its use in the motor. It is barely possible that experiments conducted along lines might materially assist in solving the problem.

The greater amount of surface that can be presented by the broken-up fuel, the better. This apparently means that each tiny particle should be a sphere. Secondly, it means that each tiny particle should be a hollow sphere, and the thinner the wall the better. Exactly how to do this commercially is still in the realm of the unknown.

The fuel question is unquestionably a serious one at the present time, but it is the writer's belief that it is but temporary. The path of least resistance will undoubtedly be the application and utilization of kerosene, not as attempted through the utilization of existing types of carbureters, but with a device distinctly constructed and embodying the requisites for the purpose.

When such a device is brought about, it will permit the utilization of enormous quantities of this class of petroleum to be used, which is now more or less of a drug on the market.

The next step, and especially for commercial purposes, will be the utilization of the heavier category of petroleum and such other oils as tar oil and oils from the lignites, deposits of which in the great Northwest are almost limitless.

The following qualifications are desirable:

First.—The particles of oil should enter the cylinder prior to an injection of air.

Secondly.—That the breaking up of the fuel is better accomplished if the oil meets the injection air in some portion of the injector at right angles. A circuitous passage is obviously desirable, but its resistance should not be too great in cases where a great number of injections are required per minute, as this delays the delivery of the fuel to the heated air contained in the cylinder, and also delays the total inflammation of the mass.

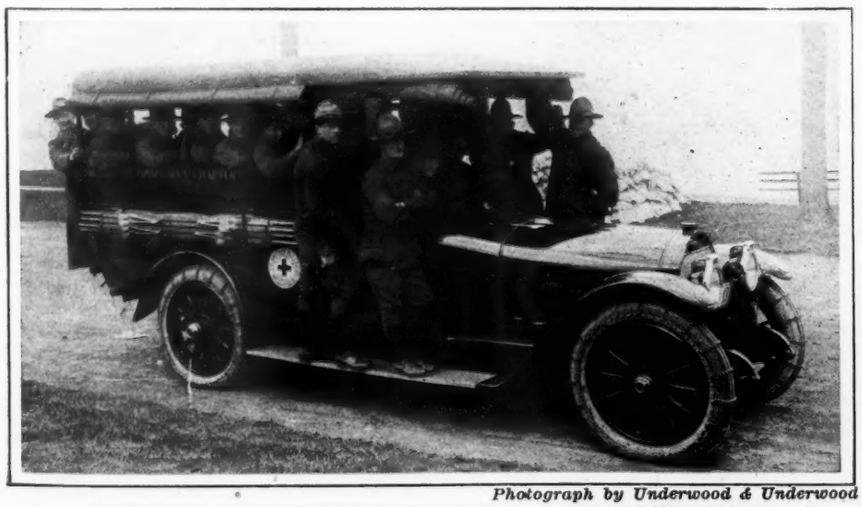
Bridgeport Red Cross Wins Ambulance Prize

WALTER B. LASHAR, president of the American Chain Co., has kept his pledge to the Bridgeport Chapter, American Red Cross Society, to give an ambulance as an incentive to the Red Cross campaign recently conducted there, when the chapter should reach 10,000. The membership exceeded 10,000 by 6000 when the drive ended.

The body of the ambulance was made by the J. G. Brill Co. of Philadelphia. It is mounted upon a standard Locomobile chassis, equipped with a six-cylinder, 65-hp. engine. There is capacity for four men on litters suspended by coil springs and heavily hooked to prevent side sway. Twelve men may ride upright on heavily cushioned seats with two attendants on the steps and two on the driver's seat. Litters are carried when not in use on racks outside the body. A medical cabinet is fashioned on the right panel by the driver's seat.

A special compartment is arranged to carry a reserve supply of 25 gal. of gasoline in 1-gal. tins, in addition to the regular 30-gal. tank, thereby giving a cruising radius to the ambulance of 500 miles of heavy driving.

The ambulance is to be put in service at once for both civil and military emergencies. The Bridgeport hospital has been selected as its permanent home.



Photograph by Underwood & Underwood

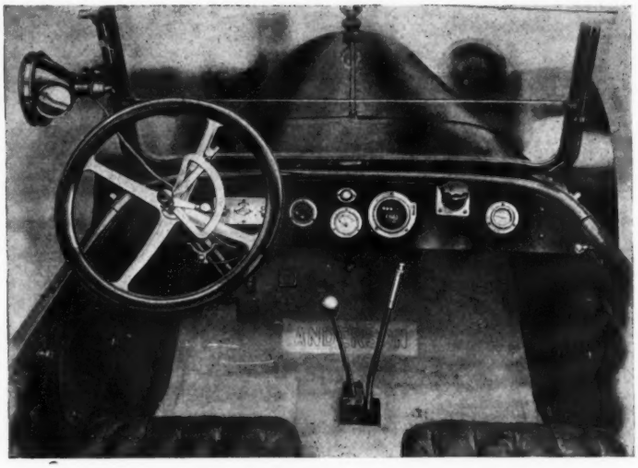
Ambulance given to Bridgeport Red Cross for securing 10,000 members

Three Bodies for Anderson Six

5-Passenger Touring Car—2-Passenger Roadster Convertible Into 5-Passenger Touring Car—Continental Engine

THREE styles of bodies are included on the Anderson Six selling at $1,295. These include a five-passenger touring car and a two-passenger sport roadster convertible into a five-passenger touring car. A Continental L-head block engine, 3¼ by 4½, and developing more than 40 hp., is used. The engine is combined with clutch and gearbox to form a unit suspended on three points. It has a piston displacement of 223.95 in.

The carbureter has no adjustments outside of an air valve control at the side of the steering column. It is fed from a tank in the cowl. Lubrication is a constant level combination force-feed and splash system. Cooling is by a centrifugal pump.



Divided front seats in five-passenger convertible roadster

The frame is 20-point carbon steel, cold rolled. The side members are 4½ in. deep, the flanges 1½ in., and the stock is 5/32 in. thick. Springs are semi-elliptic and the main leaves are chrome vanadium steel, the front being 36 by 2, seven leaves; and the rear 56 by 2, nine leaves.

The gearbox gives three speeds forward and one reverse, the shafts being mounted on Gurney ball bearings. The gearshift lever is mounted directly on top of the box. A Borg & Beck clutch is used.

The rear axle is a full floating design with heavy pressed steel housing. Spiral bevel gear and pinion are used. All bearings are Bower rolled. Front wheel bearings are Gurney.

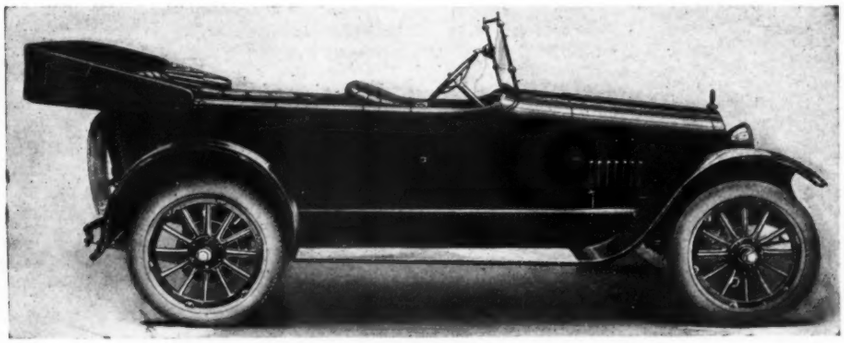
The service brake contracts on the rear wheel drums and the hand brakes expand inside the same drums. Raybestos is used in both sets.

The steering gear is Gemmer, being an irreversible worm and gear type. Other features include Westinghouse ignition, Zenith carbureter, Westinghouse engine starter and lighting system, and 33 by 4 tires.

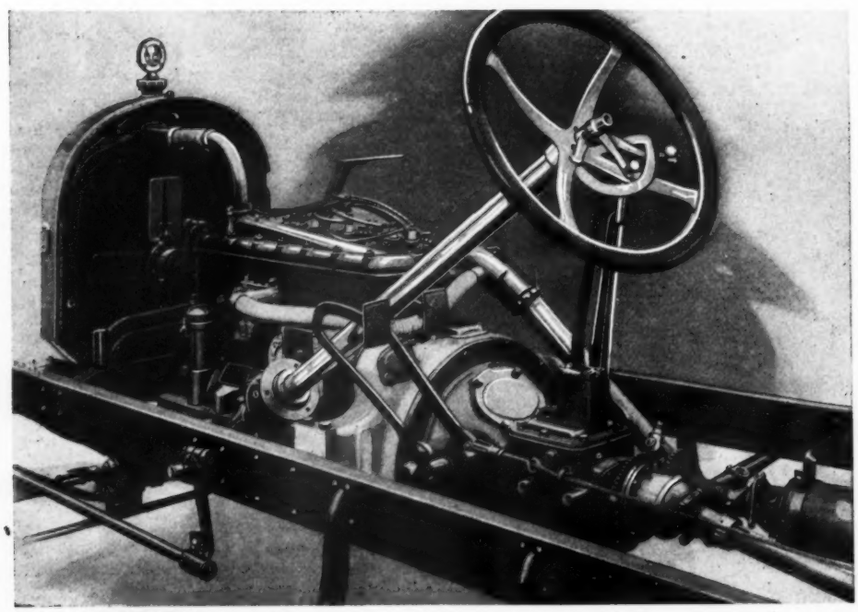
A distinctive creation is the Convertible Sport model, which may be either a two-passenger racy runabout or a roomy five-passenger touring car. In the runabout form it has a sloping rear deck which gives no clue as to the design hidden beneath. It may be quickly transformed by folding back the rear deck to form the back of the rear seat.

Every attention has been given for comfort. The backs are shoulder high, the seats are extra wide, the upholstery is deep.

The Anderson Six is completely equipped. A full list of extras comes with the car. For convenience in night driving there is a Hawthorne spotlight; a tonneau foot rest heater provides warmth in winter. There are also a Kellogg engine-driven tire pump, a Boyce Motometer, Klaxon horn, gasoline gage on instrument board, a Stewart speedometer, ammeter, one-man top of Rayntite, with envelope of same material; adjustable ventilating windshield, five demountable rims, tire carrier, jack and full set of tools.



Five-passenger Anderson Six touring car, selling at $1,295



Anderson Six 3¼ by 4½-in. power plant which develops over 40 hp.

MANUFACTURERS' MERCHANDISING

Manufacturer to Distributor, Dealer, Buyer

Eleventh Article of The Automobile's New Department

Independent Dealers Should Distribute Electric Vehicles

Require More Expert Salesmanship—Central Station Still a Big Factor —Dealer Should Know Possibilities of Distributing Center

By P. D. Wagoner
President General Vehicle Co.

Digest of a paper read before the recent meeting of manufacturers of electric cars, trucks, industrial trucks, batteries and tires

ELECTRIC truck manufacturers were among the first in the automobile field to more or less universally adopt the branch office method of selling. Experience has demonstrated, however, that the electric truck cannot be marketed through branch offices as successfully as is a typewriter, a dictaphone, or a burglar-proof safe, except at prohibitive selling cost in all but a few cities. So a transition from highly specialized *retail* selling to a broader, and, we believe, in view of changed conditions, a more general use of *wholesale* distribution is a natural and logical one.

Electric and gasoline commercial vehicle manufacturers have in the past approached the proposition from different angles:

(a) Electric in general by direct retail salesmen.

(b) Gasoline in general through dealers.

A reason for this was that the electric is limited in its successful application and requires more expert salesmanship. Gasoline trucks were and are still sold, generally speaking, wherever an order can be secured. This adds to the natural handicap of the electric, which finds its field invaded from all sides. This condition has probably influenced the continuation of retail selling.

Independent Dealers' Co-operation

(c) Their commercial department was not as active as competing gasoline truck salesmen.

Experience indicates that, except in individual cases, we cannot depend upon the central stations for such co-operation as its real interest in the situation warrants from the standpoint of its being a permanent beneficiary of every vehicle sold. It would seem to be to the best interests of all manufacturers to secure active independent dealers, and then for both the manufacturer and the dealer to secure such co-operation from the central station as may be obtainable.

Real co-operation to be of value should include the following:

(a) *Purchase and use of electric vehicles wherever they can be efficiently applied.*

(b) *Purchase of such vehicles through the local agent as a stimulation to him—a stimulation both financial and psychological.*

(c) *Have power solicitors actively canvass for prospective business and turn it over to the dealer to follow up.*

(d) *Co-operate in a financial way, as to terms of payment, etc., in equipping dealer's garage with suitable apparatus.*

(e) *Make effective and attractive vehicle charging rate; wherever possible, not over 4 cents. See that several people in the general office are familiar with and can quote vehicle rate figures intelligently.*

We have about despaired of securing much help from central stations, either in the selection of the right dealer or in assisting him after he has taken on our line. Yet we need the central station. In very few cases will it be necessary for the central station to commit itself to any expense of importance, and a little co-operation of the right kind from time to time, particularly during the dealer's first year, would be of great help. Furthermore, it should be a good investment, because most of the electric trucks sold go on central station lines.

Our policy is to secure dealers in every city over 25,000 population, and, other things being equal, we give preference in the following order:

(a) *Organizations with garage facilities.*

(b) *Central stations.*

(c) *Individuals without previous electric vehicle experience whom we can train to sell.*

It is better business to have a good dealer in the city of Birmingham, Alabama, for instance, than to try to cover that city from an office in Atlanta. The dealer knows most of the business men around him and can cash in on the disposition to patronize a brother townsman. He is familiar with local conditions. He can afford to patiently develop prospects, for a fair nucleus of vehicles in his garage will carry the overhead of his business, leaving him his agency discount practically clear profit.

Even at the cost of a substantial discount, it is generally to the manufacturer's advantage to sell through a dealer. In the long run it is cheaper, except in large centers, and where he can sign up a dealer for a definite number of trucks per year it steadies his production, distributes the burden of introductory selling, and, altogether, is a safer and wiser method of securing distribution.

Reorder Business

For several years to come, however, it probably will be difficult to secure good electric truck dealers in the quantity desired. We must concede that it is easier to sell gasoline trucks than it is to sell electric, particularly low-priced gas trucks. It is hard to get the prospective dealer to see that while it takes a little longer to break the ice with the electric, once the ice is broken in a locality, care being used to properly adapt each truck to its work, the reorder business on the electric will be greater and more sure than on the gas truck. There is less free service in the case of the electric, since there are fewer breakdowns. Each electric sold aids in the sale of another, and combining such sales with the income from the garage, the electric truck dealer can be sure of a constantly growing income.

Dealer with Garage an Asset

While it is true that a service station is not nearly as necessary for an electric truck as for a gas truck, the dealer who has a garage is an asset to the electric vehicle manufacturer. Possibly the dealer may already have an electric passenger agency, in which case the addition of the truck line is simplified, but after the dealer has sold, say, fifty trucks, better results are often achieved if these are segregated in separate garages. We do not encourage the placing of electric trucks and gas trucks in the same garage, as the facilities necessary for the adequate care of the two types differ somewhat, and if the electrics are in the minority they are likely to suffer in the way of comparative attention even though the electric inherently needs less roundhouse work.

In determining the policy of distributing commercial electric vehicles it should be borne in mind that, in the first place, the commercial electric is not so easy to sell as the pleasure car, and, therefore, if a dealer handles both he is very likely to follow the line of least resistance and not actively exploit the commercial electric.

Exploiting of the commercial electric, especially from the standpoint of avoiding mis-sales, requires education as to the features of superiority of the commercial electric over other types of commercial vehicles, and a knowledge of its limitations.

In the past this has made it particularly difficult to secure effective dealers, but as time goes on and a knowledge of the characteristics of the electric becomes more broadly disseminated, this condition is changing, although the decision of any company as to its policy must necessarily rest upon its own individual conditions.

Direct Representation

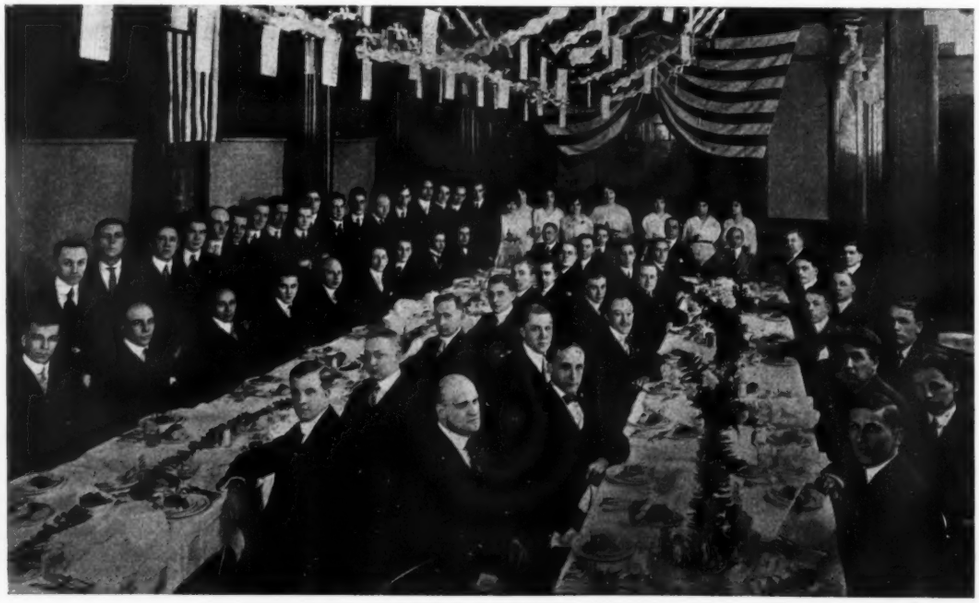
Any company deciding the problem of securing distribution for its product should take into consideration the size and location of such distributing center, and the potential business or demand for that product. Direct representation where such representation is financially profitable is apparently the best method to pursue in the very largest center.

Conditions have now developed to the point where the policy of dealer representation in the smaller centers is effective. This is primarily due to the fact that individual dealers are becoming better informed regarding the efficiency of the electric vehicle, but there is still much to be done in educating the dealer. In accomplishing this, the central station's co-operation is of vital importance.

Read the Article on
Farm Tractor Design
Page 993

Falls Efficiency Club

Illustrated herewith is one of the monthly meetings of the Falls Efficiency and Safety First Club. This body was organized by the Falls Motors Corp., Sheboygan Falls, Wis., to suggest and carry out safety recommendations, to plan and create methods whereby plant efficiency will be increased and to promote a feeling of good fellowship between employer and employee. A meeting is held each month at which recommendations or suggestions are passed upon. Specialists are invited to address the club.

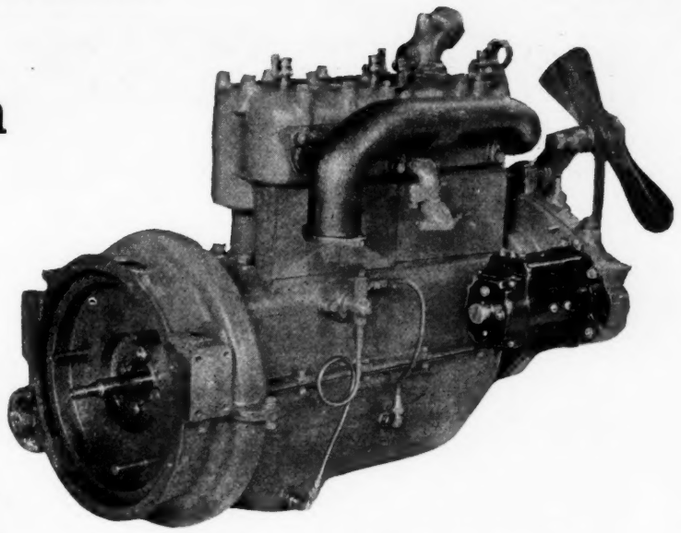


Detachable Head on New Bell Four

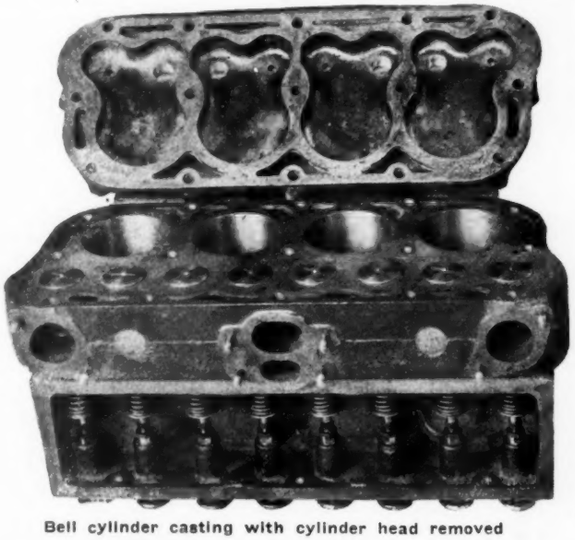
Five-Passenger Touring and Four-Passenger Roadster Sell for $875

A FOUR-CYLINDER, 35 hp. chassis, selling at $875 as a five-passenger touring car and a four-passenger roadster and styled Model 17, has been brought out by the Bell Motor Car Co., York, Pa. The new model is featured by its 3½ by 5 block cast engine which has a detachable cylinder head.

Lubrication is by constant level splash, with plunger pump operated by a special eccentric on the camshaft. Valves are 1⅝ in. in diameter with 45-deg. seats, with the head of cast iron electrically welded to a high carbon steel stem. There is a 1⅞ in. free gas opening with a mushroom type lifter, hardened and ground. The crankshaft is of 40-50 carbon steel alloy, double heat treated, drop forged and balanced, while the case-hardened camshaft is 1 in. in diameter. Atwater Kent ignition, thermo-syphon cooling and Zenith carbureter are used.



Four-cylinder engines used on the new Bell. Note mounting of starting motor and exhaust and intake manifold connections



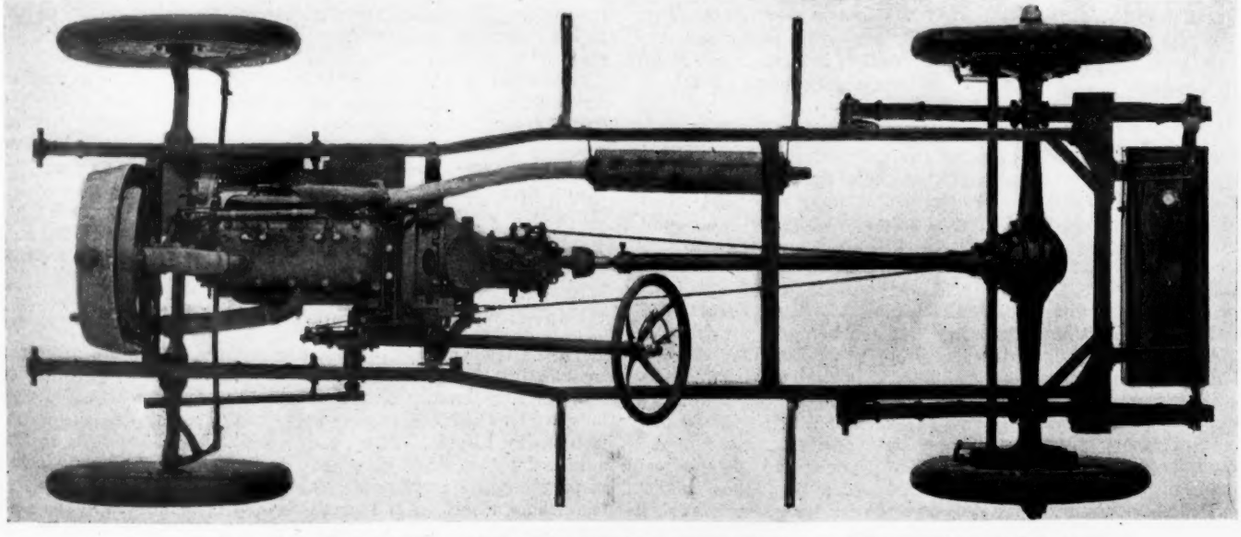
Bell cylinder casting with cylinder head removed

Bell Transmission

The Bell transmission consists of the Covert make, three speeds forward and one reverse, with nickel steel gears and shafts and roller bearings on the driveshaft and countershaft. The Borg & Beck single dry disk 8 in. clutch is used. Control levers consist of left-hand drive, center control at the side of the emergency lever. The Bell company is using the Dyneto two-unit system in combination with Bendix drive and Willard storage battery.

A pressed steel 20-30 carbon steel channel section 4½ in. high frame is used. The upper half of the rear spring bracket is integral. There are three cross members, including a front member under the radiator. The front axle is of I beam design, while the rear axle is floating, with inspection plate at the rear, and annular bearings. The wheelbase and tread are 112 and 56 in. respectively.

The Lavine steering gear, of the thread screw type, is irreversible and adjustable for wear. Wood artillery 31 by 4 wheels are used. Brakes are external contracting for service, and internal expanding for emergency. Both brakes are 12 in. in diameter with a 2-in. face.



Plan of new Bell chassis. Note brake equalizer arrangement and rigid mounting of fuel tank

Type of steam-heated press used in the production of Povasco radiator caps. The machines for steering wheels are in the background and are similar in form, differing only in size

Making Bakelite Parts

Pouvailsmith Corp. Secures Smooth Exterior on Cores Partly Wood and Partly Metal—Warm Hand and Ordinary Steering Wheels and Radiator Caps Among Products

WITH every discovery of science there is found an industry to follow, making the commercial application. Sometimes it comes quickly and sometimes slowly, but it always comes. One of the most striking recent examples of this law is seen in the discovery of Bakelite or Condensite, for it has revolutionized the manufacture of many articles. For ignition parts its qualities have made it practically universal, but the fairly high cost has had a restricting effect upon other applications. Still for such things as radiator caps, steering wheel rims, small handles, knobs, etc., it is an ideal substance and is gaining favor steadily despite the cost.

Five Main Advantages

The principal advantages of the substance for such parts of an automobile are, first, its considerable mechanical strength which enables it to resist injury; second, perfect adhesion to metal; third, that changes in temperature do not affect it in the slightest; fourth, the ability to mold to any form; and, fifth, the high polish which is lasting and yet easily produced. From the manufacturing viewpoint it is an excellent material to handle because it can be molded in and around anything, the starting form being a powder.

A new factory devoted exclusively to automobile parts of Bakelite, excluding all ignition goods, is that of the Pouvailsmith Corp., Poughkeepsie, N. Y. Although the company's name is doubtless best known in connection with its special type of steering wheel, a larger part of its business is the making of radiator caps for high grade cars. The wheel business is growing fast, about 100 a day being now made, and of these some 20 per cent are the tilting pattern having the Warm Hand feature.

In making the rims for the different styles of wheel the process is in general the same. First of all a core is roughly shaped out of wood. Four or six pieces cut in arcs from a board and planed to a circular section are used for this core, the pieces being spliced and attached to each other by wire binding or pins. The wooden wheel thus made has little strength, in fact the whole purpose of it is to economize Bakelite. The latter material is amply strong when in the tubular section it assumes when molded a ¼-in. thickness all around the wood.

The ends of the spider are set in slots cut in the wood core so the Bakelite covers and fills the junction, leaving the under side of the rim just as smooth as the upper. Just at present a manufacturing difficulty is the absence of any standard for the upper ends of steering columns, as this prevents wheels being made except to suit some particular steering gear. Although it is possible to machine the hole in a spider after the wheel is finished it is much more desirable from the viewpoint of manufacturing efficiency to do this before the spider and rim are together.

Whole Wheel Under Pressure

The sections of the Bakelite portion of the rim are prepared by packing the powder into a mold where it is compressed and slightly heat. This makes a fragile arc about a foot long and of semi-circular section, the consistency being not unlike dry biscuit. The wood rim is, of course, held to the spider by the slots mentioned before, so the next process is to place the sections of Bakelite on the wood and to put the whole wheel in the press, where it is heated to a high temperature and heavily compressed for a time, which varies

a little but is approximately 30 min.

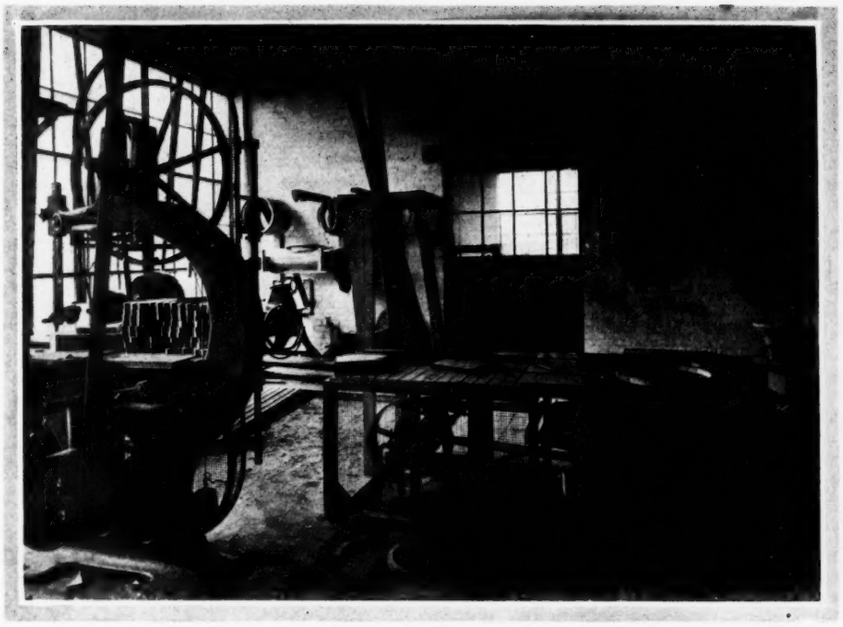
From this the wheel comes out with a dull black finish and with a fin all around the middle, both inside and outside. This is produced by the heavy pressure and cannot be avoided because an excess of Bakelite must be used to insure that the wheel is perfectly solid and material driven into every space around the wood core. Thus the fin has to be removed, which is done rapidly by hand filing.

With the tilting wheel the fitting of the catch holding the middle part of the spider follows, after which the wheel is buffed to remove all file marks and give the luster, this completing the manufacture.

The Warm Hand type of wheel is almost as simple to make as the plain sort. On the wood core a short coil of flat strip is wound for one hand, carried around to the opposite side along the rim, wound round in a second coil and earthed to the nearest end of the spider. The other end is brought out adjacent to, but not touching, the opposite spider arm. Here it becomes a wire which is led to the switch button on the left boss of the spider. The Bakelite is applied as usual, the wiring all being embedded, covering and insulation being thus performed at one operation.

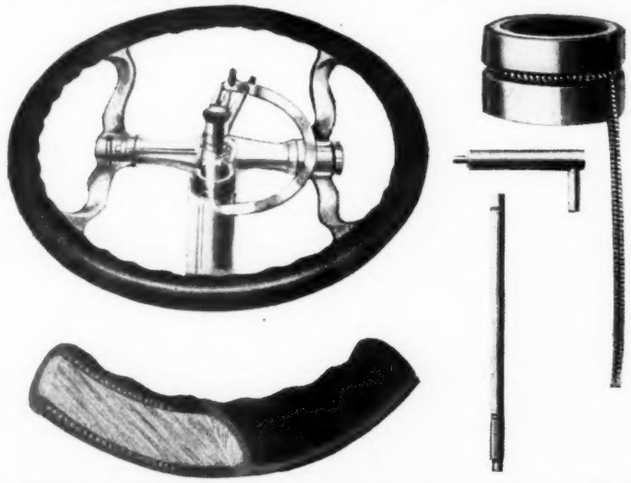
From the switch button a horizontal connection is made through the center part of the spider to a commutator block which forms the upper end bushing for the steering column. This is another Bakelite piece into which is molded the ring that makes contact, whatever the rotational position of the wheel, this being connected to a wire that passes down the steering column *inside* the outer tube. At the bottom of the column a hole is drilled, the wire brought through and led to the battery. Little carbon brushes make the moving contacts and there is nothing to be seen anywhere on the wheel to disclose its character except the switch button.

In making the radiator caps, which are the largest part of the Pouvailsmith product, the metal part, usually brass, is supplied finished with the thread already cut. It goes direct into the dies, surrounded by Bakelite and after treatment merely requires buffing after the flash is removed. The total quantity of material being smaller than in the case of the steering wheels the amount exuded is likewise small and the trimming operation is performed very easily and quickly.



Woodworking room in Pouvailsmith plant where the cores are made for steering-wheel rims. A pile of cut sections is shown on the left by the bandsaw, and an assembled wheel before being trimmed to round section appears on the table of the machine on the right, where it is about to be milled to shape

An impression gained by examining the great variety of radiator caps and handles for gearshift levers, etc., is that the possibilities of Bakelite for small parts have not yet been appreciated fully. It is an almost everlasting material, quite unaffected by heat and cold, and it takes a higher polish and a more lasting one than almost any other substance. For limousine door handles, for control levers, for switch buttons, even for the handles on cabinets or internal fittings, it would seem superior to metal, owing to its complete freedom from tarnish. Almost any part which would usually be nickeled because of constant handling can be made more roughly of wood or metal and Bakelite coated and produce a piece more durable and equally good in appearance. Price is, of course, a restriction, but this is not prohibitive if the quantities are reasonably large and the shape is simple. The expensive part is the Bakelite itself. This needs to be a minimum thickness according to the nature of the part—on a steering wheel about a quarter inch, on smaller things it may be thinner. The possibility of making parts with a partly metal and partly wood core, and still getting an even exterior, is an important factor, and one to which engineers should give attention.



Section of a Povasco Warm Hand steering wheel, showing the heating coil wound around the wood core before the Bakelite is applied and then baked in. The way in which the Bakelite forces itself under the wire should be observed. Right—Details of the commutator and wiring of the Warm Hand wheel

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Electric Trucks vs. Horse

COST figures compiled by the New York Electric Vehicle Section of the N. E. L. A. indicate that the use of an electric truck in place of horses will save the owner $800 per year. It is assumed that the truck can do the work of a light delivery outfit consisting of three horses and two small wagons.

The total cost for the latter during 1 year is $1,780.91, estimated as follows: Board at $1 per day, $1,095, shoeing at $2.25 per month, $81; services of veterinary, $30; clipping, $5.55; repairs and painting of wagons, $200; repairs to harness, $45; amortization for horses at 20 per cent (assuming the value of a horse at $200) $120; amortization for wagons and harness (assuming the value at $375), $75; insurance, $25.86; interest on investment, $103.50; total, $1,780.91.

It is figured that an electric truck doing the same amount of work as the horse and wagon equipment can be operated and maintained at a cost from $900 to $1,000 a year. The advantages which the electric advocates point out are that the electric outlives the horse, can make double the speed, is cleaner, and requires less space.

Five Empire Truck Axles

Can Be Equipped To Transmit Drive and Torque in Four Ways—Special Worm-Drive Axles Used

FIVE worm-drive truck axles capable of carrying pay loads of from 1 to 6 tons are being put out by the Empire Axle Co., Dunkirk, N. Y. Two of these, standard models, are adapted to 1-ton pay-load trucks. In addition the Empire company manufactures special worm-drive axles for electric passenger cars, electric trucks, gasoline fire trucks, armored trucks and industrial trucks.

These axles can be equipped to transmit the drive and torque in four ways:

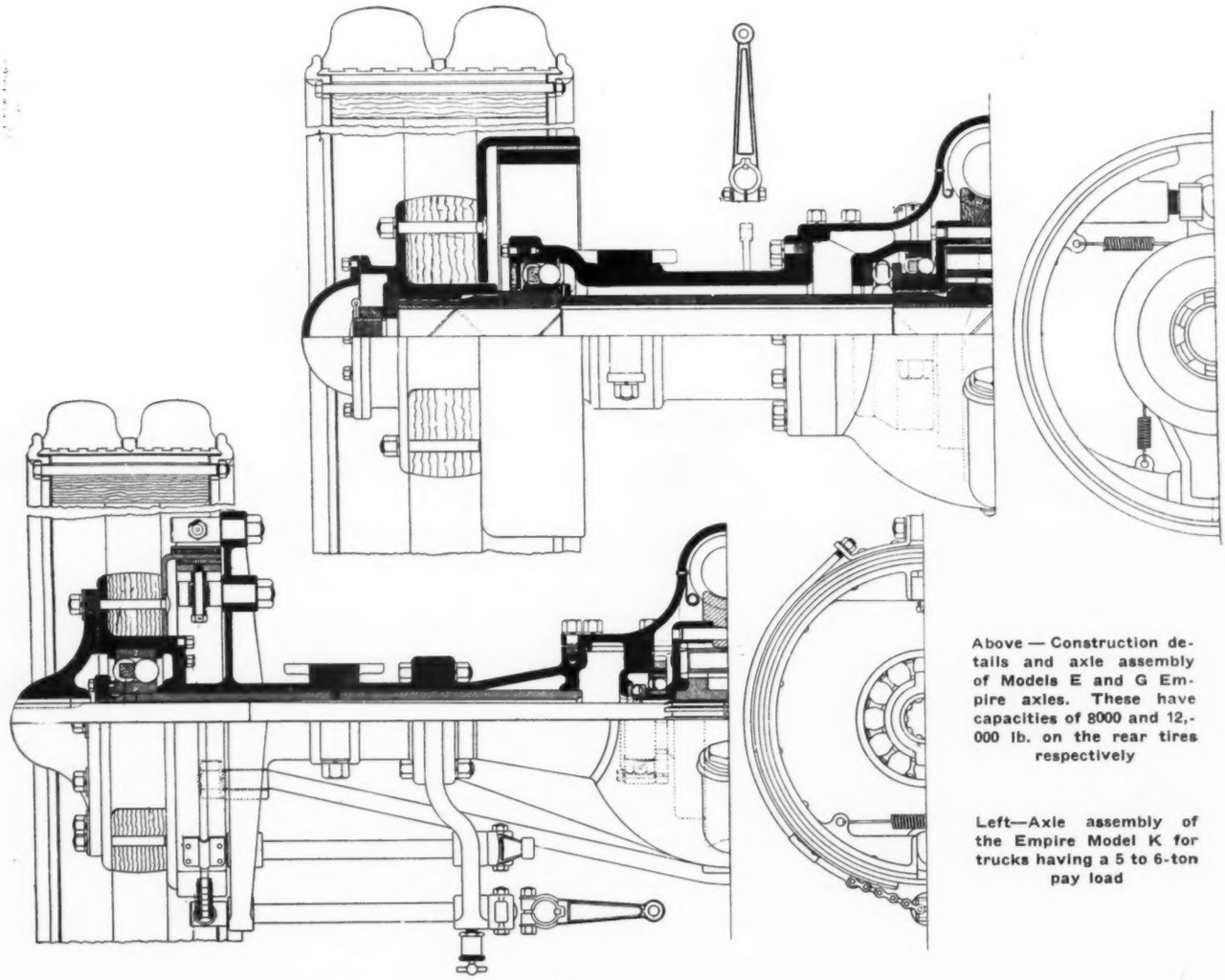
1. Drive and torque through the springs.
2. Drive by radius rods and torque through the springs.
3. Drive by springs and torque by torque member.
4. Drive by radius rods and torque by torque member.

They are floating axles, with the driveshaft transmitting the power from the differential to the wheels without carrying any of the load. The driveshaft also serves to hold the wheel in alignment, as it has a fixed hub cap firmly secured to the outer end of the axle driveshaft. This gives a leverage the length of the axle to hold the wheel in alignment, the fulcrum point being at the wheel bearing and the aligning force at the differential. This construction avoids stresses which ordinarily would be absorbed by the axle housings and tubes.

The worm and worm gear are straight-type worms mounted in a carrier as a complete unit, which is assembled and adjusted before installation. In this way the unit requires no adjustment after being placed in the axle housing. The worms, which are of steel, are case-hardened and ground to correct tooth form. The worm gear is a special phosphor bronze alloy of high tensile strength cut with generator teeth.

As regards ball-bearing equipment, including radial and thrust bearings, the self-aligning S. K. F. type is used throughout. The driveshafts, differential gears, worm and all bolts are made of 3½ per cent nickel steel, with the driveshaft heat-treated and the worm and differential gears hardened. The differential is a spur-gear type containing eight pinions and two side gears to give a maximum tooth contact and bearing surface. The side gears are splined to receive the driveshafts. No bushings are used, the pinions running on hardened-steel pins.

There are two 1-ton axles, known as Models A and F. The Model A is a Hotchkiss drive type with 38 in. spring center,



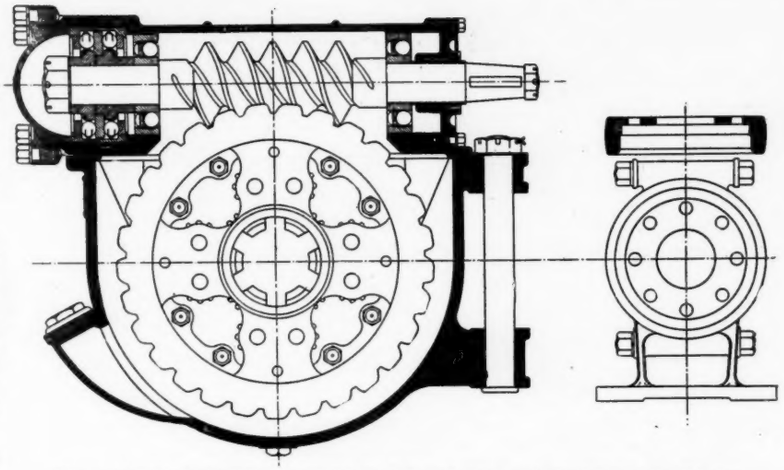
Above — Construction details and axle assembly of Models E and G Empire axles. These have capacities of 8000 and 12,000 lb. on the rear tires respectively

Left—Axle assembly of the Empire Model K for trucks having a 5 to 6-ton pay load

adapted for a 2½-in. spring. It has a final gear ratio of 7.2 to 1, and is what is known as a three-quarter floating type. In accordance with the standard Empire design, the axle housing is constructed in three pieces, the center housing carrying the worm gearing as a complete unit. All the mechanism runs in a constant bath of oil, no grease cups being required, as the brake shafts are oiled from within.

The brakes are expanding, having 13½-in. drums and 2¼-in. brake surface. The bearing equipment is a heavy-duty ball for the worm thrust, straight roller type for the worm radial bearings, double row radial and thrust ball bearings for the wheels, with the worm-wheel bearings of large surface, hardened and ground. No adjustments are provided on any of the bearings, as they are not deemed necessary.

The rated load capacity of the Model A axle is 3550 lb. on the tires. This includes chassis, body and pay load. The weight of the axle is approximately 450 lb.



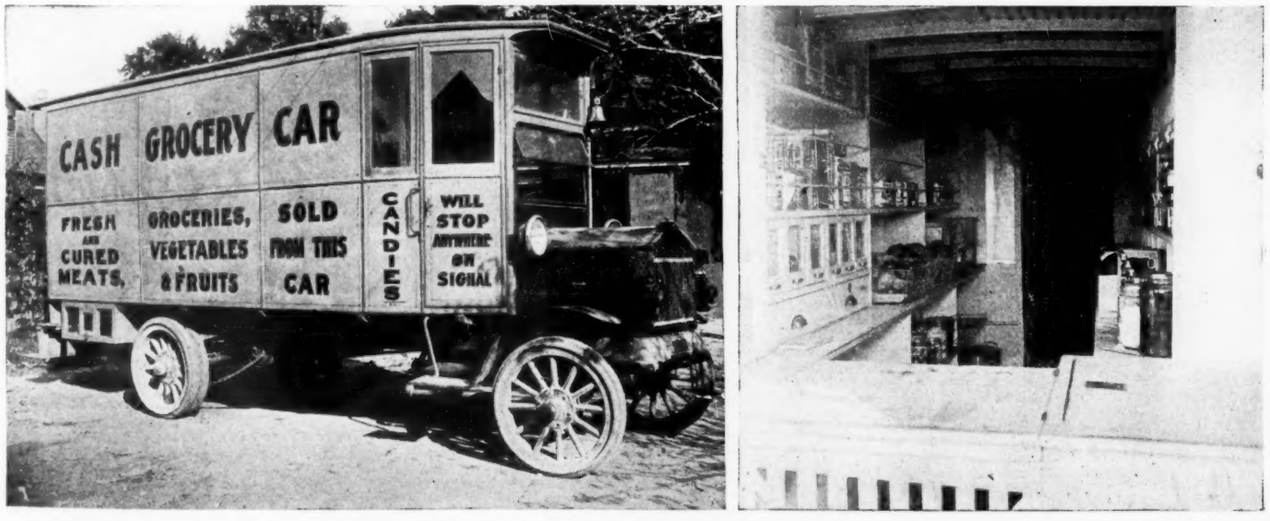
Worm carrier assembly for Model E, 2 to 2½-ton, and Model G, 3 to 3½-ton rear axles, also Model K, 5 to 6-ton

The Model F axle follows along the same line as the general design described. It differs from the Model A, however, in that it has an ultimate carrying capacity of 3850 lb. on the rear tires. The brake connections are external instead of internal and the housing consequently is of different shape. The brakes are contracting instead of expanding, being operated by the chain-toggle arrangement, which also is standard on the larger types of axles.

Models E and G are similar to Model F, except that Model E is adapted for pay loads varying from 2 to 2½ tons and Model G for pay loads from 3 to 3½ tons. The carrying capacities are respectively 8000 to 12,000 lb. on the rear tires. The approximate weights are 800 lb. for the 2 and 2½-ton axle and 950 lb. for the 3 and 3½-ton.

The Model K rear axle is the largest size and is adapted for trucks with 5 to 6-ton pay loads. The axle weighs approximately 1800 lb., with a nominal carrying capacity of 20,000 lb. on the rear tires. It is constructed to meet the requirements of extremely heavy loads. It has a solid supporting shaft running completely through the axle from wheel to wheel, and the drive from the differential to the wheels is transmitted by heavy tubes splined at either end. These tubes are particularly adapted to withstand shock and transmit torque. In this design there are no radial bearings which assume any side thrust. The thrust caused by rounding corners, which has a tendency to push the hubs through the spokes, and the side thrust of the worm gear are received by two single end thrust bearings on either side of the differential. The driving tubes have a bearing at either end on the solid supporting shaft and bearings of great length in the differential hub. This provides a box construction distributing the heavy radial load on four radial bearings instead of two-wheel bearings alone. The self-aligning ball bearings used throughout provide against any deflection occurring in the axle, each radial bearing receiving an equal division of the entire load at all times and under all conditions. This construction does not sacrifice any of the advantages of ease of assembly or quick removel of parts. It is not necessary to take the axle from the chassis to remove the working parts of the axle. The driving tubes can be withdrawn from either side of the housing. The supporting shaft can likewise be removed and the carrier containing worm and worm gear, differential, bearings and other parts lifted out as a complete unit.

Grocery Store Mounted on 2-Ton Reo Chassis



Side and rear view of the latest type of grocery store on wheels. Note the electrically-operated bell on the windshield bracket in the view on the left. It is used to notify the housewife that the truck has arrived so that she may have her purse and order ready. Note the interior shelving and the top of the ice box at the right. A 2-ton Reo chassis is employed

Automobile Calendar

ASSOCIATIONS AND CLUBS

May 25 — Cleveland, American Automobile Assn., Annual Meeting, Hotel Hollenden.
June 4-6—Hot Springs, Va., National Assn. of Automobile Accessory Jobbers, Convention.
Sept. 12-14—Atlantic City, N. J., Motor and Accessory Manufacturers, Mid-Season Meeting.
Sept. 25-28—Pittsburgh, National Assn. of Purchasing Agents, Convention.

CONTESTS
1917

May 30—Cincinnati, Ohio, 250-Mile Race.
May 30—Uniontown, Pa., Local Races.
May 30—Newark, N. J., Track. T. B. Shoemaker, promoter.
May 30—Washington, D. C., Track, Middle Atlantic Motor Assn.
June 16—Chicago, Ill., Speedway Race.
June 23 — Cincinnati, Ohio, Speedway Race.
July 4—Omaha, Neb., Speedway Race, Championship.
July 4—Uniontown, Pa., Speedway Race.
July 4—Tacoma, Wash., Speedway Race.
July 4—Visalia, Cal., Road Race,
July 4—Spokane, Wash., Track Race.
July 4—Benton Harbor, Mich., Track Race.
July 14—Rochester, N. Y., Hillclimb.
July 15—Missoula, Mont., Track Race.
July 17-19—Buffalo, N. Y., Intercity Reliability.
July 22—Anaconda, Mont., Track Race.
July 29—Great Falls, Mont., Track Race.
Aug. 5—Billings, Mont., Track Race.
Aug. 17—Flemington, N. J., Track Race.
Sept. 3—Uniontown, Pa., Speedway Race.
Sept. 3—Cincinnati, O., Speedway Race, Championship.
Sept. 6—Red Bank, N. J., Track Race.
Sept. 8—Hillclimb, Pike's Peak, for stripped stock chassis.
Sept. 15—Providence, R. I., Speedway Race, Championship.
Sept. 22—Allentown, Pa., Track Race.
Sept. 28—Trenton, N. J., Track Race.
Sept. 29—New York Speedway Race, Championship.
Oct. 6—Danbury, Conn., Track Race.
Oct. 6—Uniontown, Pa., Speedway Race.
Oct. 13—Richmond, Va., Track Race.
Oct. 13—Chicago Speedway Race, Championship.
Oct. 27 — New York Speedway Race.

SHOWS

May 5-13—Chicago, Used Car Show, Coliseum, Chicago Automobile Trade Assn.
June 20-27 — Montreal, Que., Used Car Show, Coliseum, Montreal Automobile Trade Assn.
Aug. 6-10—Fremont, Neb., General Tractor Demonstration.
Sept. 2-9—Spoken, Wash., Interstate Fair.
Sept. 9-15 — Milwaukee Show, State Park Fair, West Allis.
Sept. 9-15 — Milwaukee, Wis., Fall Show, Wisconsin State Fair, West Allis, Milwaukee Automobile Dealers.
Oct. 13-28—Dallas, Tex., Dallas Automobile & Accessory Dealers' Assn. State Fair.

S. A. E. Calendar

Midsummer Meeting

June 25-26—Washington, D. C.

Standards Division Meetings

MAY

25—Aeronautic, New York.
29—Research, New York.

JUNE

1—Miscellaneous, Chicago.
5—Starting Battery, Detroit.
7—Engine, Detroit.
8—Transmission, Detroit.
14—Electric Vehicle, New York.
25—Standards Committee, Washington.

Section Meetings

MAY

25—Indiana, Claypool Hotel, Indianapolis. Albert Champion will talk on Spark Plugs.
26—Pennsylvania, Outing to Grenloch Park. Automobiles will line up 1.30 at Bellevue Stratford Hotel, Philadelphia.

Engineering Calendar

American Railway Master Mechanics' Assn.
American Institute of Electrical Engineers.
Master Builders' Assn.
American Society of Heating and Ventilating Engineers.
Association Iron and Steel Electrical Engineers.
Mining and Metallurgical Society of America.
Society of Automotive Engineers.
Illuminating Engineering Society.
National Electric Light Assn.
National Gas Engine Assn.
American Society for Testing Materials.
American Institute of Metals.
American Foundrymen's Assn.
Society Naval Architects and Marine Engineers.

MAY

29-June 1 — Nat. Elec. Light Assn. Convention at Atlantic City.

JUNE

2—Assn. Iron & Steel Elec. Engrs. monthly meeting Phila. section.
5-7—Nat. Gas Engine Assn. annual meeting at Chicago (Sherman House).
8—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Ohio section at Cleveland.
9—Assn. Iron & Steel Elec. Engrs. monthly meeting Cleveland section.
11—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Ill. section at Chicago.
11—Amer. Soc. Heat & Vent. Engrs. monthly meeting Michigan section at Detroit.
12—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Mass. section at Boston.
13-14-15 — Amer. Ry. Master Mech. Assn. convention, Greek Temple, Atlantic City, N. J., Hdqrs. Marlborough-Blenheim Hotel.
14—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Penn. section at Phila.
15—Illum. Eng. Soc. Pittsburgh section, Office Building, Lighting and Inspection Trip through City and County Building. Mr. S. G. Hibben.
16—Assn. Iron & Steel Elec. Engrs. monthly meeting Pittsburgh section.
18-19-20 — Master Car Bldrs. Assn. convention. Greek Temple, Atlantic City, N. J. Hdqrs. Marlborough-Blenheim Hotel.
20-22—Amer. Inst. Chem. Engrs., Ninth Semi-Annual Meeting at Buffalo.
21—Mining & Met. Soc. of Amer. New York section monthly meeting at Engrs. Club.
26-30—Amer. Soc. for Test Mat. annual meeting Atlantic City, Hotel Traymore. Business meetings, reception and golf tournament.

JULY

7—Assn. Iron & Steel Elec. Engrs. monthly meeting Phila. section.
9—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Ill. section at Chicago.
9—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Mich. section at Detroit.
10—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Mass. section at Boston.
12—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Penn. section at Phila.
13—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Ohio section at Cleveland.
14—Assn. Iron & Steel Elec. Engrs. monthly meeting Cleveland section.
16—Amer. Soc. Heat. & Vent. Engrs. monthly meeting New York section.
21—Assn. Iron & Steel Elec. Engrs. monthly meeting Pittsburgh section.

AUGUST

4—Assn. Iron & Steel Elec. Engrs. monthly meeting Phila. section.
9—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Penn. section at Phila.
10—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Ohio section at Cleveland.
11—Assn. Iron & Steel Elec. Engrs. monthly meeting Cleveland section.
13—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Ill. section at Chicago.
13—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Mich. section at Detroit.
14—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Mass. section at Boston.
20—Amer. Soc. Heat. & Vent. Engrs. monthly meeting New York section.
21—Assn. Iron & Steel Elec. Engrs. monthly meeting Pittsburgh section.

SEPTEMBER

1—Assn. Iron & Steel Elec. Engrs. monthly meeting Phila. section.
8—Assn. Iron & Steel Elec. Engrs. monthly meeting Cleveland section.
10-14—Assn. Iron & Steel Elec. Engrs. annual convention at Phila.
10—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Ill. section at Chicago.
10—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Mich. section at Detroit.
11—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Mass. section at Boston.
13—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Penn. section at Phila.
14—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Ohio section at Cleveland.
15—Assn. Iron & Steel Elec. Engrs. monthly meeting Pittsburgh section.
17—Amer. Soc. Heat. & Vent. Engrs. monthly meeting New York section.
20—Mining & Met. Soc. of Amer. monthly meeting N. Y. section at Engrs. Club.
24—Amer. Inst. Metals at Boston.
24—Amer. Fdry. Assn. annual meeting at Boston.

OCTOBER

6—Assn. Iron & Steel Elec. Engrs. monthly meeting Phila. section.
8—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Ill. section at Chicago.
9—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Mich. section at Detroit.
10—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Mass. section at Boston.
11—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Penn. section at Phila.
13—Assn. Iron & Steel Elec. Engrs. monthly meeting Cleveland section.
15—Amer. Soc. Heat. & Vent. Engrs. monthly meeting New York section.
17, 18, 19—Amer. Gas, Inst. at Washington, D. C.
18—Mining & Met. Soc. Amer. monthly meeting New York section Engrs. Club.
20—Assn. Iron & Steel Elec. Engrs. monthly meeting Pittsburgh section.

NOVEMBER

3—Assn. Iron & Steel Elec. Engrs. monthly meeting Phila. section.
8—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Penna. section at Phila.
9—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Ohio section at Cleveland.
10—Assn. Iron & Steel Elec. Engrs. monthly meeting Cleveland section.
12—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Ill. section at Chicago.
12—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Mich. section at Detroit.
13—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Mass. section at Boston.
15—Mining & Met. Soc. Amer. monthly meeting New York section at Engrs. Club.
15, 16—Soc. Naval Arch. & Marine Engrs. annual meeting.
17—Assn. Iron & Steel Elec. Engrs. monthly meeting Pittsburgh section.
19—Amer. Soc. Heat. & Vent. Engrs. monthly meeting New York section.

DECEMBER

1—Assn. Iron & Steel Elec. Engrs. monthly meeting Phila. section.
8—Assn. Iron & Steel Elec. Engrs. monthly meeting Cleveland section.
10—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Ill. section at Chicago.
11—Amer. Soc. Heat. & Vent. Engrs. monthly meeting Mich. section at Detroit.